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The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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REVIEW·OF·MINING

Introductory.—During the last two or three months, the variations in the price of metals has been the most fruitful topic of discussion among mining engineers. In the early part of May standard copper was forced to £140, but since then the price has slowly reverted to a more normal level, and on 12th of this month had reached £90. The standard market with its small turnover can be manipulated with comparative ease. Electrolytic cannot be so easily controlled, and the price has been less subject to fluctuations. At the time of writing, the quotation is £135, fully 50% higher than standard. In the days before the war the margin between standard and electrolytic was £3 or £4. The price of zinc has been falling during the last few weeks, and the present quotation £44 may be considered fairly reasonable seeing that over £100 was paid in April. The fall has been caused by the commencement of operations at many of the new smelters in America and possibly the expectation of increased supplies from British plants. The starting of the Ekibastus plant in Siberia will also bring new supplies to the Allies. Antimony is another war metal that has developed weakness. It should be remembered that there never was a wide market for it and production has been forced since war began. Lead has held its own well. The last of the metals to feel the effects of war demand, it seems destined to hold its advance longer than the others. The slight recession in silver is incident to changes in China. It must be remembered that this general sagging of prices is a healthy sign, in that it indicates increased hopefulness for an early termination of the war, and improved shipping and smelting facilities. Despite the recession metal prices are still so high as to spell prosperity at the works, at least till war taxes must be paid.

Transvaal.—The output of gold during June on the Rand was 735,194 oz. and in outside districts 26,570 oz., making a total of 761,764 oz. worth £3,235,767, as compared with 751,198 oz., 26,483 oz., 777,681 oz., and £3,303,377 during May. The number of natives employed on the gold mines at the end of June was 192,809 as compared with 194,765 at the end of May and 166,248 at the end of June 1915.

The dividends paid by the gold mining companies of the Rand during the first half of the year 1916 totalled £3,634,795 as compared with £3,844,848 a year ago. In general terms it may be said that the decrease is due to extra costs and taxes. From the mining point of view the fall in the productiveness and profit-earning capacity of the central, eastern, and western Rand is counterbalanced by the increase of yield and profit in the Far East Rand.

The plan for reorganizing the Transvaal Coal Trust was accepted by a large majority of shareholders at the meeting held in Johannesburg on June 23, the opposition of the Albu group not having any substantial effect on the policy proposed by the Consolidated Mines Selection. As already recorded in this column, the name of the company is to be changed to the 'Rand Selection Corporation,' and the Consolidated Mines Selection is providing £300,000 working capital.

Production is to be resumed at the Premier diamond mine in a month or two, on a limited scale, which will be regulated according to the demand for the stones. At this mine there is no reserve of blue ground on the surface, as the disintegration is done mechanically instead of by weathering. During the idleness of the main plant, some of the old dump left behind from earlier mining operations was washed, with returns averaging better per ton than is now obtained from blue ground.

The Verdite mine in the Kaap valley near Barberton is attracting attention once more, owing to the activities of the controller, Mr. T. D. Cunningham. The mine takes its name from the green talc, which is worked as an ornamental stone. Talc of more ordinary quality is also abundant, and as some of it contained gold a 5-stamp mill was erected. This happened some years ago. Mr. Cunningham has found, however, that the production of talc for the hundred and one uses in the manufactures will afford the basis of a much more lucrative business, and with this object in view the output of the mineral is now being greatly increased.

Rhodesia.—The output of gold during May was valued at £323,783 as compared with £339,386 in April and £318,898 in May last year. The Cam & Motor is being worked at a loss, the yield per ton being only 23s. 10d. and the working loss 1s., as compared with a yield per ton of 30s. 5d. and a working profit of 4s. 4d. per ton at the end of last year. Eileen Alannah also is giving lower returns, the yield per ton being 36s. as compared with 51s. at the end of last year. Golden Kopje has been worked at a loss for five months. At Rezende the better grade ore in the central section is practically exhausted, and the return per ton is only 15s. 8d. as compared with a recent average of 24s. The returns at Shamva are remarkably regular with an output at 15s. per ton and a working cost of 9s. per ton. The gold output at Falcon has regained its normal level.

At the Rhodesia Broken Hill, the lead-smelting operations are to be expanded, and by the beginning of next year the output of lead should be 900 tons per month. From June of last year to the end of May, an experimental smelting plant produced 1000 tons of lead, and during this time the method of treatment of the zincy ore was provisionally settled. Two new furnaces have been ordered. Delivery has already been commenced, and it is expected that their erection will begin in August. The directors have made arrangements for the provision of the £30,000 capital required, and for the discharge of the company's present indebtedness of £26,000.

West Africa.—The output of gold during May was worth £132,976 as compared with £135,976 in April and £142,123 in May 1915. The yields per ton at Abbontiakoon, Cinnamon Bippo, and Prestea Block A have been falling recently.

The Prestea Block A has repaid the whole of the loan, amounting to £175,000, advanced by the Central Mining & Investment Corporation and the Fanti Consolidated, so that future profits are available for dividends. During 1915 the profit, after allowing £39,155 for depreciation of plant, was £14,378, and for the first quarter of this year the working profit was £27,017. During the three months, 74,040 tons of ore averaging 37s. 6d. per ton was disclosed by development. The sinking of the Prestea shaft has been resumed and it is now down to 1027 ft.

The shipments of coal from the Udi deposit in Nigeria, 100 miles north of Port Harcourt, have been commenced. This new source of supply of fuel will be of immense value in extending railway communication, and will be of great help to the mines. As was the case with the manganese deposit in the Gold Coast, little was heard of the venture until operations were actually begun. We are informed that the Imperial Institute has the geological and calorific investigations in hand, and that an account of the coal and the deposit will be published in the next Bulletin.

Australasia.—The prospective life of the Great Boulder mine, according to present estimate, is about two years. On the nineteen levels, from the 300 ft. to the 2500 ft., the reserves vary in content from 7 dwt. to 41 dwt., the highest assays being obtained as might naturally be expected in the upper levels, so that the average of the remaining ore is practically the same as that of the ore which has been mined during the last dozen years, $14\frac{1}{2}$ dwt. per ton. In the lower levels the width of the ore-shoot proves greater than expected as stoping proceeds, and averages 17 ft. instead of 15 ft.; but as the assay of the ore on these levels is only half the average of the present reserve, this widening will not have much effect on the ultimate profits. The lode below the 2500 ft. level is barren, and prospecting laterally by diamond-drill has not revealed anything of value. The Great Boulder mine has one of the best of records as a steady and profitable producer of ore. During the twenty years of its existence, gold worth £10,000,000 has been extracted, and approximately half has been distributed as dividends.

The Sons of Gwalia company has instituted a prospecting department, and several parties of men are to be sent out. The men will be paid wages, and will have an interest in any property eventually worked. The life of the mine was prolonged a few years ago as a result of Dr. Malcolm Maclaren's geological researches. The formation of a prospecting department is another evidence of the business shrewdness of the managers.

A new copper deposit has been discovered in the Northern Territory of Australia by Mr. G. Laurie, a prospector in the employ of the Department of Mines. From his preliminary statement it appears that the deposit is an extensive one. The deposit is near the head of the Negri river, in the watershed between the Victoria river in the Northern Territory and the Ord river in West Australia.

The Waihi Grand Junction company provides an example of the unjust incidence of the excess-profits tax. The results for 1915 showed a great improvement over those of previous years, when the profits had been unduly decreased by strikes and expenditure on machinery. The board is still in negotiation with the Inland Revenue authorities, and in the meantime the publication of the report and accounts for the year is postponed.

The developments at the lowest level, 1270 ft., at the Broken Hill South have been mostly disappointing so far, as we recorded in our May issue. Since then, the results of diamond-drilling on this level have been rather more encouraging. Two holes have yielded cores up to the average of the mine, 18 to 20% lead and zinc and 9 to 12 oz. silver per ton, over widths of 25 to 30 ft. No. 2 shaft has been sunk to 1370 ft., and driving south has been begun.

Amalgamated Zinc (De Bavay's) has been selling its zinc concentrate in America lately, and the manager, Mr. H. W. Gepp, has been in that country studying electrolytic zinc. The future of this method of treatment is sufficiently promising to induce the company, along with other Australian groups, to formulate a plan for treating their concentrates in this way. The Electrolytic Zinc Co. of Australia has been formed with a capital of a million pounds, and the proposal is to erect a works in Tasmania using current from the Government's hydro-electric plant. Gilbert Rigg, long with the New Jersey Zinc Co., has joined the staff of the Amalgamated and gone to Australia to take part in the new work.

Cornwall.—A sixth level is being opened on the South Pig lode at the Geevor mine, and the ore so far developed is of higher grade than in the upper levels. The assays show the richest part, 12 inches wide, to contain 200 to 300 lb. of black tin per ton. The stoping width is from 3 to 4 ft., and the additional rock taken out contains varying amounts of cassiterite.

The new lode at East Pool continues to develop excellently. It has been intersected on the 190 fm. level, and in the cross-cut the lode averages 201 lb. metallic tin per ton over a width of 10 ft. The rise from the 212 fm. level has been connected with this cross-cut. The ore in the rise is also of high grade. The west drift on the 212 fm. level was advanced during June for a length of 71 ft. in ore averaging 133 lb. metallic tin per ton over a width of 6 ft. This is the biggest body of rich ore disclosed in a Cornish mine for many a year.

India.—Prospecting in the upper levels at the Mysore mine has disclosed ore of fairly high grade. This work is on the 790 ft. level in McTaggart's section. The most recent reports show that the lode varies from 1 to $2\frac{1}{2}$ ft. wide, and the assay-value $1\frac{1}{2}$ to $2\frac{1}{2}$ oz. per ton. In a rise above the level, the lode continues to be of the same promising nature.

We give in another part of this issue a résumé of the Burma Corporation's report for 1915. The Tiger tunnel is expected to make connection with the orebody in September. The tunnel will be 7850 ft. long and the point of intersection will be 660 ft. vertically below the surface. About 1000 ft. of the tunnel will be driven from the bottom of the internal shaft and at that point will meet the heading from the open. Development during the year has added a million tons to the reserve, which stood January 1 at 2,300,000 tons averaging 27·5% lead, 22·2% zinc, and 25·4 oz. silver per ton. In addition it was estimated that a further 733,000 tons will be developed above the level of the Tiger tunnel. During the first half of the current year an additional 500,000 tons has been proved. The problem of producing lead and zinc concentrates to the best advantage is still being studied, and before the end of 1916 it should be possible to draw plans for a 350 ton concentrator. In the meantime ore high in lead is being smelted, and during 1915 the output of lead bullion was 13,976 tons containing 17 to 36 oz. silver per ton. Half of this bullion was shipped to London, and half was refined on the spot. The capacity of the refinery is being increased.

Malaya.—The lodes of the Pahang Consolidated have shown many variations in the tin content of the ore as sinking proceeds. Three years ago we recorded a substantial improvement with depth in Willink's lode. Subsequently the developments on a lower level indicated that the high-grade ore did not persist. The latest cables refer to Nicholson's lode, which has not done well lately. In the upper levels this lode was rich, but below the 400 ft. level it became narrow and poor. At the 500 ft. and 600 ft. levels the results were disappointing. Now comes the news that on the 700 ft. level the lode is found to be 4 ft. wide, assaying 10% of tin.

United States.—The boom in steel production that has characterized the last half year has set furnace-men figuring upon ore supplies. The *Iron Age* estimated in June that to continue pig-iron making on a 40,000,000 ton basis, that upon which the furnaces have been working for some months, would require 73,700,000 tons of ore for the year. Allowing for net imports and outside production this would necessitate an output from the Lake Superior mines of 62,000,000 tons. At the record-breaking rate of shipment that had continued through May this could just about be accomplished provided 1,000,000 tons be taken from stocks. Demand has, however, eased off a bit, the unfilled orders of the Steel Corporation on June 30 having been 9,640,000 tons. This represents a decrease of about 300,000 tons, the first setback since April 1915. May holds the record. The great expansion of the iron and steel business has created a record demand for manganese, tungsten, and other metals incidentally used in steel making.

The directors and shareholders of Stratton's Independence have abandoned any expectation of acquiring a new property in America, and have notified their consulting engineer, Mr. Philip Argall, that he is not to continue his efforts in this direction. Mr. F. W. Baker, the chairman of the company, is more hopeful of finding a suitable property in Russia, and has in fact a particular property in view.

Canada.—Not only in the United States but in the British half of North America war business is proving enormously stimulating to the metal industry. New industries are springing up in all parts of the Dominion, and manufacturing plants have orders far beyond their capacity, especially in view of the labour shortage. The Nova Scotia Steel Co. has started building steel ships on a large scale at New Glasgow, N.S., and the Dominion Steel Corporation, for the year ended March 31, reported the largest earnings in its history. After allowing for interest, depreciation, discount on bonds, and all similar items the balance available for distribution amounted to $3,995,225. Our Toronto correspondent writes of the activity at Cobalt and Porcupine, but in the West also the mining companies are active.

Mexico.—Military operations in the northern states are for the present at a standstill, the United States troops maintaining their position but not advancing. The State troops have been mobilized and sent to the border in order to permit using the whole of the regular forces in Mexico. The Carranza government avoided a direct conflict with the United States by surrendering a few venturesome troopers who had been captured, but the difficulties seem to have been avoided rather than solved. It is said that it will require six months for the United States to organize and equip the 300,000 men reported to be demanded by the general staff before undertaking complete pacification of the country. Despite troubles in the north, mining continues in the southern states. At Pachuca the Santa Gertrudis is operating at a little less than half capacity, and at El Oro the Esperanza and Las Dos Estrellas have resumed operations. During May, the Esperanza treated 12,000 tons of ore, and the Las Dos Estrellas 18,000 tons. The railway service from Vera Cruz is maintained, though slow and irregular. The cost of supplies has increased greatly, labour is paid on the basis of pre-war wages, on a gold basis, and the export tax has been raised to 10%.

South America.—The pitch of the orebody at the Morro Velho mine of the St. John del Rey Co. is tending to flatten at depth, and the angle is now about 35° as compared with 45° higher in the mine. The cross-cut on Horizon 20, at 5826 ft. vertically below outcrop, has not yet reached the orebody, and will be longer than originally expected. On Horizon 19, the length of the orebody so far proved is 890 ft., and the quality of the ore is as good as on the level above. The yield of gold per ton has increased during the last few years, having gradually advanced from 44s. 4d. in 1910 to 48s. 5d. in 1915. The heat is very great in the lower workings, and in the cross-cut on Horizon 20 the temperature is as high as 107°F. The local workmen make no objection, however. A plant for cooling and drying the incoming air is to be erected with the object of improving the conditions. Mr. George Chalmers has completed his 28th year of service as manager of this mine. He is now in England taking medical advice.

At the Porco tin mine in southern Bolivia the new mill started work in July last, and up to the end of December produced 103 tons of 58% concentrate from 8020 tons of ore. The experimental mill also extracted 26 tons from 456 tons. The average yield of concentrate per ton was 1·4%. Harold Allman Lewis, the manager, estimates the ore reserve at 261,500 metric tons averaging 2% metal.

Russia.—Copper production figures for 1915 are now available, and the total for the year is given as 1,650,270 poods (26,315 tons) as against 2,017,830 poods (31,957 tons) in 1914. The Ural district showed a gain amounting to 700 tons. The Caucasus Copper Company, an important producer in the south, did not, as is well known, operate. The Sissert has continued drilling at the Degtiarsky mine with, we understand, excellent results. Though the ore reserve is being increased, the mine will not be equipped for the present owing to the difficulty and expense of getting prompt delivery of the proper machinery. Russian mining shares have shown increased liveliness recently and there is a hint that additional capital is to join in this enterprise. A profits tax which will apply to mines has been levied, but the rates are much less than the British tax.

The trial runs of the Ekibastus zinc smelter belonging to the Irtysh Corporation have been most satisfactory, all the departments, including roasting, distilling, and refining, working smoothly from the start. The refined spelter is 99·8% pure. During the current month regular deliveries of metal on government contracts will be commenced.

Korea.—Sale of the Kapsan mining concession by the Collbran-Bostwick group to the Kuhara interests has been announced. The concession was obtained before Korea passed to the Japanese, and being on the northeast coast and difficult of access has been but slowly developed. The ore reserve is stated to be 168,000 tons of $10\frac{1}{2}$% copper ore and it is estimated that £150,000 has been so far expended. At a sale price of 3,000,000 yen the owners will have just about doubled their money, though in selling they sacrifice probable future profits that might well be much larger. However, in the Suan concession they have remaining a large and profitable field for further enterprise. The Kuhara firm, of which Fusanosuke Kuhara is, we believe, still the head, is not new to copper production, and in the rapid development and equipment of the Hitachi mine, situated between Tokyo and Sendai, has shown great enterprise. The Suan concession continues to give good profits, the Seoul Mining Co. reporting $94,810 net from 16,432 tons for April. Dr. Malcolm Maclaren has completed his geological studies of the area and has begun a similar survey of the Oriental Consolidated properties. It is a curious fact that despite the great area and value of the ground held by the Oriental, no careful geological study of the concession has been made previously. It is a pleasure to record the rumour that within a few weeks of Dr. Maclaren's arrival on the ground, he was able to make suggestions that have already resulted in opening important orebodies.

China.—Mining business in China, so far as foreigners are concerned remains at a standstill, owing to political and legal difficulties. Messrs. Lindsey and Wheler are reported to have finished their work in connection with the codification of the mining laws, but it is a question whether there is any government strong enough to put a new code into effect, however good it may be. Parliament is to reassemble, and temporarily at least the country will be re-united. Men on the ground are doubtful as to how permanent the new conditions will prove, and whether China will be the exception in finding a short cut from imperialism to democracy.

EDITORIAL

JOURNEYS of observation are among the most interesting, as they may be the most valuable, experiences falling to the lot of professional men. Our own journey to South Africa, just concluded, will always rank high both as to pleasure and profit. Having no responsibility for results, a visitor can study a process or an undertaking with an open mind, and in South Africa, where the widest of open-door policies obtains in technical matters, a visitor who comes away ignorant has only himself or lack of time to blame. From Capetown to Katanga and from Lorenzo Marquez to Kimberley we had only to ask in order to be shown every intimate detail of the work in hand, and it is a great pleasure to acknowledge this uniform courtesy and spirit of eager wish to help. Space limitations forbid printing the long list of those to whom even special acknowledgments are due. We can only hope that future numbers of the Magazine will prove sufficiently interesting and suggestive to make some slight return to our many friends, old and new, in South Africa.

SINCE the establishment of the Entente Cordiale the project of constructing a tunnel from England to France has been revived. A few days ago the holding of a meeting of shareholders of the Channel Tunnel Company demonstrated that the plan is still being carefully nursed. We need not dilate on the international and commercial bearings of the problem. We have, however, an especial interest in the tunnel, owing to the fact that before its construction was commenced the advice of a geologist was taken with a view of choosing the best stratum in which to construct it. Professor W. Boyd Dawkins and his coadjutors made a geological survey of the English and French coasts, and deduced the structure of the Channel bed by soundings of various sorts. They chose a dry horizon in the chalk, and the workings, which were driven half-a-mile or so before the military authorities intervened, were in consequence never hampered with water. Since those days the shaft has been used for the development of the underlying coal measures, and in passing down through other strata in the chalk, overwhelming volumes of water were encountered. But for the wisdom of the civil engineers in consulting a geologist, the construction of the tunnel itself would as likely as not have been rendered almost impracticable by the same water difficulty.

EVERYBODY will be glad to hear that Mr. R. T. Bayliss has recovered from the injuries caused by the explosion of a Zeppelin bomb at his house in the eastern counties. It says much for his indomitable spirit that he was able, after this accident and the consequent serious operation, to preside at the annual meeting of the Buena Tierra Mining Company, and to conduct the proceedings with his accustomed distinction.

QUOTATIONS on the London Metal Exchange are not representative of the actual business done in the metal trade of the country. The Government is the biggest purchaser of copper at present, and its contracts are not based on these quotations. No statement has been made public with regard to the prices paid for the copper bought in the United States, but the price for Australian copper delivered in this country is generally £100 per ton. For instance the Wallaroo has a contract at this figure for the delivery of 500 tons per month during the current year.

EARLY last year we recorded the judgment of a full Court of Appeal upholding the right of an enemy firm to constitute itself as a British mercantile organization by simply effecting a registration at Somerset House. Of the seven judges, six took this view, and only one, Lord Justice Buckley, had the courage to base his opinion on common-sense rather than on the technicalities of law. The House of Lords has this month upset the judgment of the Court of Appeal, and by a unanimous decision has upheld Lord Justice Buckley's contention that no amount of legal jugglery can change an enemy into a friend.

IT MAY be said without fear of contradiction that the late Silvanus Thompson was the most versatile and cultured gentleman who ever occupied a professor's chair at a technical college. His lectures, whether before scientific societies, popular audiences, or to his own students, were prepared with extraordinary care, and were delivered with perfect elocution, and he could lecture with equal facility in the English, French, German, and Italian languages. During the thirty years of his tenure of the position of principal of the City and Guilds College in London, he gave a scientific training to multitudes of young men who have subsequently become successful electrical engineers. His 'Elementary Electricity and Magnetism' and 'Dynamo-electric Machinery' were the earliest standard text-books on a new branch of engineering, and they continue to hold a first position. To the advanced student in natural philosophy, his translation of Gilbert's 'De Magnete' is a great classic.

IN another part of this issue we give particulars relating to the vertical retorts for zinc smelting used at the Grillo works in Germany. The information comes from an article published in *Metall und Erz*, the author of which jubilantly hails the invention as a wonderful advance in the metallurgy of zinc, an invention calculated to paralyse the efforts of the enemies of the dear fatherland directed to the establishment of a competitive zinc industry. Since the war began the British public has taken the news of German technological progress somewhat sceptically, sometimes with good reason and sometimes without. In the present instance the claim deserves serious investigation. The advantages of the vertical retort are that the action is continuous, and that the expensive labour required for charging and discharging is largely eliminated. It would be necessary to operate at an even heat, and while it is probable that the retorts would last longer, the recovery or the grade would seem certain to suffer. With the usual retorts pure spelter is made at moderate heat early in each run, and later the heat is raised to drive over the last of the zinc, though this lowers the grade by also distilling lead and other metals. Just how this difficulty would be met with continuous retorts is not clear.

The Zinc Corporation.

The Zinc Corporation has been the victim of mosquito attacks lately. First the British lawyers thought the company's funds better applied in litigation than in the production of lead and zinc; next, the Australian metallurgical ring squeezed the company in the matter of its lead output, and annexed for itself the company's proposal for a co-operative zinc business; and lastly a group of professional agitators acquired shareholdings and proceeded to launch a virulent but fortunately abortive attack against the board. The English libel law permits shareholders to exchange written and printed communications among themselves that could not possibly be published in the press. Not even that most daring of papers, *The Financial News*, thought for a minute of reproducing Mr. F. C. Auld's circular. We are, for this same reason, precluded from discussing the details of this pitiful diatribe, but that fact does not trouble us, for in any case we should hesitate to devote much space to what was after all arrant nonsense. The circular complained of the board's inefficiency in handling the metal position in Australia, and alleged that the reserve funds had been badly placed. Of all agitations against directors, none was ever so utterly futile. The Zinc Corporation is engaged in legitimate mining and metallurgical operations, and has had an important influence in the improvement of methods for extracting metals from their ores. The board therefore does not deserve to be dubbed a gang of unprincipled adventurers, as Mr. Auld would have us believe. In this connection it is well to recall the earlier history of the company. Most of our readers will remember that it was formed in 1905 by Bewick, Moreing & Co. for the purpose of beneficiating enormous heaps of zinc tailing at Broken Hill by means of the newly discovered flotation process. The Broken Hill mines in early days had reaped big profits from the oxidized lead ores containing silver, but were confronted by a serious problem in connection with the ores in the sulphide zone, for the zinc content became large, the two sulphides were found to be intimately mixed, and the rhodonite gangue could not be removed efficiently by water-concentration on account of its high specific gravity. Wet and fire methods were tried on extensive scales for the purpose of treating the ore direct and extracting both lead and zinc, the Ashcroft process of the Sulphide Corporation being the most prominent wet method, and the Fry-Everitt process of the Smelting Corporation leading the way in the fire methods. All these proposals came to nothing, and a reversion was made to water-concentration, with the object of obtaining as much galena concentrate as possible, leaving the blende and gangue behind. The discovery of the principle of flotation afforded the means of separating the blende from the heavy gangue. Mr. H. C. Hoover, then a partner with Bewick, Moreing & Co., saw the opportunity presented, and under the auspices of his firm, the Zinc Corporation was formed for the purpose of purchasing the old tailing heaps and producing a zinc concentrate therefrom. It is not too much to say that the company was the first to demonstrate publicly the commercial value of the flotation principle, though it is of course true that the Minerals Separation company and the Sulphide Corporation had done excellent work, and that the Broken Hill Proprietary and the North and South companies had solved the flotation problem by means of the Potter and De Bavay patents respectively. Minerals Separation and the Sulphide Corporation, however, conducted their work privately, and the world was none the wiser. The Potter and De Bavay plants have also been behind closed doors, and in any case there is good reason for supposing that their application is limited to the ores under treatment. The Zinc Corporation publicly demonstrated the value of the Elmore and Minerals Separation processes, and the success achieved undoubtedly gave the flotation principle its great advertisement. The business of the company did not end with the establishment of the flotation process, for after the process had been proved a success, the company acquired, at Mr. Hoover's recommendation, the South Blocks mine, and thereby began to produce lead concentrate as well as zinc concentrate, and became a mining company instead of merely a treater of old tailing. Our readers are well aware of the excellent results obtained by the company as a producer of lead and zinc concentrates, and fully appreciate the efforts of the directors in solving the complicated problem in connection with the rescission of the enemy contracts and the establishment of zinc smelting in Australia or England. As for Mr. Auld's allegations with respect to the reserve fund, it is clear that the investments were all well placed according to the current knowledge at the time they were made. It is true that both industrial and gilt-edged investments have depreciated in value, but this is an experience that has been only too general of late. Naturally if the board had anticipated the war, the reserve fund would have been placed on deposit at the bankers or in some other easily realizable form. Any general criticism as to the nature of the investments suitable for the reserve fund of a mining company is beside the mark, for it is clear that all the corporation's available funds will in future be required for the business in hand, and no outside investments will be contemplated. We may suitably conclude this article by saying once more that our sympathies are always with the people who conduct mining and metallurgical operations with distinction, and not with the agitators, who, in spite of all their talk, do not make the community any richer in material possessions.

American Capital and the Rand.

Both in London and Johannesburg there is keen interest in the proposed establishment of an American group on the Rand. Our readers already know that Mr. W. W. Mein, with the assistance of Messrs. Karl Hoffmann and Fred Searles Jr., recently made an examination of the Grootvlei and Palmietkuil, two farms belonging to Lewis & Marks and situated within the Far East Rand goldfield. Mr. Mein and his associates have returned to New York, but their recommendations have not been made public. In the absence of direct information we can only draw inferences from the general situation, but before doing so there are certain general considerations that may be pointed out.

As is well appreciated, the opening of a Far East Rand mine involves the investment of a considerable sum of money, perhaps as much as £2,000,000 for each property brought to a producing stage. Of this, as Sir Lionel Phillips stated to his fellow shareholders of the Central Mining & Investment Corporation at their annual meeting last month, from £800,000 to £1,000,000 has to be spent before any definite knowledge is secured to indicate final success or failure. Even when profits are won, the capital is locked up for five to seven years before returns begin, and the probable rate of return is not large. Upon the terms proposed by Mr. R. N. Kotze in his recommendations to the government, as to which we purpose to have a word later, the profits figure out to an actual return of only 8 to 9% in case of a property where it is necessary to sink to 4000 feet. It is to be remembered further that even this is not realizable under terms of the present gold law. Parliament, we learn, adjourned without making the changes recommended by Mr. Kotze and endorsed by the select committee appointed to investigate the matter. It would lead us too far to discuss at this time the necessity for or the nature of those changes, but the question is what attraction has the Rand for American investors just now?

It is well known that, while the United States has been willing enough to supply engineers and machinery to develop the Rand, its financiers have been chary of assuming any of the risk involved in supplying capital. Conditions, however, change and the United States now has more money available for investments than has ever been its good fortune before. It is still true that it has need for enormous sums for further development at home, and probably its power to invest abroad is much less than reading the newspapers would lead one to suppose. An experienced American banker writes us, apropos of the talk of American investments abroad, "such negotiations as we have had thus far have not indicated that any good seasoned investments have as yet been placed on the bargain counter. With such railway shares as our Pacifics selling practically upon a 6% basis, there is nothing attractive in others on about the same basis." We may further add that in a land where the small investor can still buy 7% mortgages in his own neighbourhood a speculative foreign investment must be good and must be well introduced to find a market. However, foreign shares are coming into style in America, and there can be no question but that popular imagination has been fired throughout the United States by the picture of Uncle Sam as money lender to the rest of the world. A sound foreign security properly introduced would sell readily. The amount involved in the proposed investment on the Rand is not large. Fully three times as much, or £6,000,000, has been sent from South Africa itself to London for repurchase of Rand shares since the present upward movement began in the market. In the United States the Anaconda Copper Mining Company alone spent a sum sufficient for an East Rand mine in changing its treatment plant to a new basis, at the same time spending a nearly equal amount in acquiring holdings in South America. The Guggenheims spent £3,000,000 in opening and equipping the Chuquicamata mines in Chile and, taking into account the unsolved metallurgical problems, the venture must be conceded to have been much more daring than opening a Far East Rand mine. For a syndicate headed by the General Development Company, £2,000,000 is not a large amount. In Rand finance also it is a small venture. On the basis of capitalization discussed when it was proposed to consolidate the whole Rand, it would represent but one-fortieth, certainly no great proportion to get excited about. The project can therefore be discussed calmly on its merits without heed to the wild hysterics of those who have talked about impending "Americanization of the Rand" or the cheerful cocksureness of the local estate agents, who as early as March were advising people to buy stands for building "where the American dollars are to be planted" and so make their fortunes.

From the financial standpoint we believe it would be a good thing for both the Rand and

New York if the American group should see its way to enter the field. South Africa is doing very well, but every country is helped by having a wider credit and a broader market. There are many industries aside from mining in South Africa that would make faster headway if more capital was available, and it can hardly be doubted that, appealing only to the old markets, less money rather than more will be available after the war. In a big country like America, regardless of local opportunities, there is always some money to be had for foreign use if the local investors are informed as to the country and the opportunity. If an American group opens a mine or mines there, its shares will be bought and sold in New York, and investors following their course will become informed as to other properties and so will come to buy Modders, Brakpans, and Crowns, as well as shares in the American company. Already there is some New York buying of Rand shares, but the field is virtually uncultivated and its possibilities are large. From the American point of view the advantage lies in the large measure of security that a Far East Rand investment would have. Assuming that a sufficiently large area be secured on reasonable terms, we would agree with local engineers in considering that opening a mine there, while still having interesting speculative possibilities, has most unusual assurance of success. This is an important matter to any American house that plans to go in permanently and heavily for foreign investment. To establish itself thoroughly in public confidence it must make its first big venture abroad a success, even at the price of accepting a smaller return. In the past the American mining houses have worked much less with public money than have the British and Continental groups. An American house is the actual owner of its mines rather than a trustee for scattered shareholders. Indeed, it is a common and often a just criticism that American financiers have not been always careful to fulfil the duties of trusteeship as regards minor stockholders. If American mining houses go into foreign business in a large way this must change. More public money will be used and a much broader market for mining shares must be created. At present any of the big New York houses can at once make bank collateral of any security by merely endorsing it. To protect this credit and build up a public following, the first new ventures abroad must be a success and that is why the Far East Rand appealed to New York. We regret to learn that Parliament neglected to amend the gold law at the session just closed, and since, even according to the figures compiled by Mr. Kotze, the government engineer, the mynpacht of the Grootvlei is not sufficiently large to warrant opening a mine, and Palmietkuil lies so far east as to be only of speculative interest at present, we fear that the Americans are not likely to take up the business for the present, if ever. If this prove true we shall regret it all the more in that a direct connection of the Rand with New York would, we believe, be a good thing for mining technology. On the Rand the engineers and metallurgists are accomplishing many interesting things, and much that they have evolved offers promise of usefulness in the United States, Canada, and Mexico. It is also true that much is regular practice in America that is not known or not appreciated on the Rand. If a mine were opened on the Rand by engineers reporting to an American house, there would be a much freer interchange of ideas between the two countries, to their mutual advantage. The Rand mines are, quite properly, coming more and more to be controlled and directed by men trained on the Rand. Even those now in positions of responsibility who were educated elsewhere have obtained most of their experience locally. This condition, we think, is likely to be intensified as the years go by and the Rand is so big and is geographically so far from other great mining centres, that its technical isolation grows. It would seem to us that technology then might well be the gainer by having one or more of the 40 or 50 mines manned in large part by men drawn from outside and to whom the direct line of promotion would be to mines of a different sort in another land. Granted that a Rand man would be manager, and the astute Yankees would scarcely make the mistake of sending in an outsider, we can hardly conceive that he and possibly his neighbours could derive anything but benefit from his plans and reports being submitted to the constant friendly criticism of such an engineer as Mr. J. Parke Channing, the distinguished head of the Lewissohn's staff. The one numbing influence that Rand engineers and metallurgists must fear in the future is that due to their relative isolation. It operates not only to retard their adoption of improvements developed elsewhere, but lessens their chances of winning the professional recognition and promotion that their good work merits. If American investment on the Rand can be brought about on a sound basis, the incidental benefit to mining technology would be a by-product yielding large returns.

After the War, What?

Much speculation is rife as to the after effects of the war regarding industry, and particularly as to whether we may safely anticipate a period of that quickened industrial activity known usually as 'good times,' or a slackening, a business depression, such as has come to be called 'bad times.' He would be a wise man, or a lucky guesser, who answered the question correctly, and we make no pretensions to superiority in either direction. It may nevertheless be helpful to recall certain general principles which each man may well keep in mind in making such arrangements for the future as he may individually consider to be wise. As a primary fact it may be stated that the war must be paid for, and that in time the burden will come to be distributed fairly equally over the whole industrial world. The burden will doubtless press unequally for a long time, but every people and every individual will be obliged ultimately if not immediately to assume some part of the load. The war results in destruction of goods and of men. It bears down upon both capital and labour, and upon both in the same way, namely by abnormally increasing wastage. Whether or not it bears with equally proportionate weight is a matter on which opinions differ, and where even the fundamental facts are imperfectly known. It is impossible to say with certainty how many workers have been killed, permanently or temporarily withdrawn from industry by reason of injuries, or permanently but only partly so withdrawn. All we know is that the loss in this direction is large and must become increasingly severe as the war continues. This is a loss the effect of which probably increases with the length of the war, and at a rate more nearly geometrical than arithmetical. There is also an unknown factor here in the new labour, mainly female, called into industry by the war, and the increased efficiency due to the stimulus of the emotions raised by the advent of the new labour. It is widely true that there is a fairly enormous reserve of unused energy due to poor organization of industry and the disinclination of men to work hard. There are also many places where, at a price, machinery can be substituted for men, and so the energy of fuel and falling water substituted for workers. That there have been long strides taken in this direction in all the warring countries is certain. On every side we hear of increased *per capita* production, as in the collieries and ship-yards, and equally common it is to see large plants where women workers have made good the absence of their men folk at the front. Part of this increased production is due to emotional stimulus that is not apt to survive the end of the war, but in part the gain is permanent, for most of the men and women in the shops will always be more effective workers because of their war experience, as they will also be available for more kinds of work. It is true furthermore that the men who at the end of the war come back from the front will be physically and mentally superior to what they were before the war. This is so true that many will not be willing, even if able, to go back to their old jobs, and accordingly a widespread shift is to be anticipated.

As to the waste of capital there are even stronger differences of opinion. So good an authority as Sir George Paish of *The Statist* considers that the main loss will be of the profits that might have been won by peaceful industry in the war years. Certainly the actual destruction of property, severe as it has been, is commonly exaggerated. Keen observers familiar with both situations have estimated the property loss so far incurred in Belgium, for example, as not greater than when San Francisco burned. Except for a narrow strip of most striking desolation in the actual war zone, most countries are really untouched and are even prosperous. Shipping companies have suffered heavy losses, but have made large profits and, striking a balance, are highly prosperous. Their experience may be taken as fairly typical. The war supplies that come from stock were already paid for; those made since the war opened represent current labour, and material currently mined or grown. It is true that large sums of money and credit representing savings have been spent, and obligations have been created, but these, for the world as a whole, represent shifted capital, not destroyed capital. The only things destroyed have been men and goods.

It is an interesting and important fact to be remembered that in the industrial countries capital increases faster than does population; this is easily verified by studies of census tables. The new capital cannot stay idle, but enters the market and competes with existing capital for labour. It follows that constantly increasing capital competes for a constantly relatively less amount of labour, and therefore wages continue to rise. The proportion of the return that goes to the worker must continue to increase, but the absolute return to the capitalist is continually larger because the volume of capital is larger. This is seen in mining, in that we now work on a much smaller profit-per-ton basis than a half century ago, and we pay higher wages, but the scale of operations is larger, and few if any mines of the old days gave annual returns comparable to those of the more important mines at present working. Wages have risen in all countries since the war opened; but wages must have risen whether the war came or not if industry had continued to expand. The only change possible was as to the rate of increase.

A third and most important factor in industry, and one which we are much less capable of measuring even approximately, is psychological. The state of mind of a nation is most important. It is reflected immediately in credits. When the world, or even a single nation, feels prosperous it begins to expand. When credits fail, as in the United States in 1907, labour may be as abundant and capital may be unimpaired, but expansion is checked. This is because promoters work more on the basis of hoped-for profits than accumulated savings. A large percentage of the world's business goes steadily forward at all times. It is only when the small surplus of savings and of labour is in demand that we experience 'good times.' A mining district booms when new mines are being opened and new mills are being built. In later years values shrink and we all feel poor, even though the output is much larger, because it is stationary or shrinking. The real problem, at least as regards the immediate period after the war, is how the world is going to think of itself. Will there be such a feeling of optimism as will set each idle sovereign competing for each idle man, or will there be such uncertainty or fear for the future as will send money to the safe-deposit vaults, and men to the workhouses? Obviously the answer will depend largely upon the length of the war, the character that the fighting assumes, and the nature of the final peace. It may well prove that the destruction of international confidence is more costly than the burning of cities and the blowing-up of railway tunnels and bridges. It may also prove, fortunately, that renewed faith in the power of our ideals, the removal of certain fears for the future, are worth more than an armed peace. There will be readjustments to be made, and they will be long and painful. They will vary in the different countries. The United States, for example, is temporarily gaining capital from the rest of the world, but it is already short of labour, and when the war ends it must return capital or attract an enormous stream of immigrants. In the past Great Britain has had both surplus capital and population. We have been content to use our money to develop other countries and to lose at the same time many of our best workmen. No doubt there have been compensations, but no doubt also a more nationalistic spirit will prevail in the future, and we shall be more disposed to keep men and money at home. Italy has been rich in men and poor in capital. Hence, thousands of Italian workmen have gone to other countries and returned after a season with their savings. What a larger Italy will do cannot with certainty be foretold. Russia, having both population and resources, is receiving an intellectual stimulus that seems certain to result in an enormous increase in industrial activity. The two great enigmas are Germany and France. For the former it is a question mainly of the actual terms of peace. For the latter, there are larger questions. The French are a people of great wealth and of proved ability. For centuries they set an example of enterprise both at home and abroad. For the last half-century France has been content in the main to stay quietly at home busy with her own problems. Will the war awaken the old spirit of expansion? Will France, which once explored and spread over the larger part of North America, enter keenly the contest for the world's trade, and particularly for that of South America? There can be little doubt that in that field the French, because of intellectual sympathy with the peoples of Latin America, have great advantages over Briton, American, and German. Has France merely been biding her time? These are among the questions that arise when one tries to look into the future of industry after the war. We do not attempt to answer them; we merely caution those who would do so not to overlook the importance of the third factor. It is not capital and labour alone which will determine matters; the state of mind of the various peoples will also affect the result.

Presentation of Companies' Accounts.

When investigating yearly output, yield per ton, cost, and revenue at base metal mines, we are occasionally confronted with difficulties owing to the engineer's report and the directors' and secretary's profit and loss account not always being in concordance. For instance, the engineer of a tin-mining company may report the amount of ore raised during the year and the tin concentrate produced, together with the cost incurred, while the profit and loss account gives the revenue obtained from the concentrate sold during that period. In many cases the concentrate *produced* and the concentrate *sold* are substantially different, especially so when the mine is in a distant country, and the time occupied in shipment is long and the periods between despatches irregular. If the full details are given at both mine and office, the analysis presents no difficulty, but often enough some of the details are lacking or they are not presented logically, so that the results as published in the annual report are easily misinterpreted. The presentation of the figures in connection with the work at the mine causes no difficulty and we have no criticism to make. On the other hand, the company's financial statement can be prepared in several different ways, equally accurate, of course, from the accountant's point of view, but varying in simplicity and in their appeal to the unprofessional reader. The simplest way is to wait until the whole of the product of the year has been realized, and thus to make the output and revenue therefrom cover the particular year under review. This practice, however, involves a long delay when the mines are far distant; and as promptness in the publication of a report and accounts is desirable, this method is not always the best. The alternative is to adopt what may be called the standard method of the accountant, that is to say, to credit the profit and loss account with the receipts for produce actually realized during the year, and in addition to give credit for the value, estimated or ascertained, of the stock of produce unsold on the last day of the year. From the total must be deducted the credit for the stock unsold at the end of the previous year. If the value of the stocks unsold is ascertained by actual sales within reasonable time, the necessity for estimating it and subsequently readjusting the figures is obviated, and the profit and loss account becomes all the simpler. This practice has the advantage of securing an early publication of the accounts and of presenting promptly the financial position on the last day of the company's year. If details or tonnage sold and unsold are given, they can be used in connection with those given by the engineer, and the results of the mine readily deduced. The general use of this system would greatly aid the compiler of statistics relating to production, yield and cost per ton, and working expenses, and we should therefore like to see its general adoption by accountants and auditors. Perhaps this short note will serve to attract attention to what seems to us an important matter in connection with mining.

CHEMICAL METHODS OF TIN EXTRACTION

By O. J. STANNARD.

The author discusses the chances of using chemico-metallurgical processes for extracting tin from its ores as substitutes for or in addition to wet methods of concentration, and gives details of many lines of experimental work in connection with chemical processes.

THE improvement in the extraction of tin is of particular interest just now, when joint action is being taken by the Institution of Mining and Metallurgy and the Cornish Committee for the purpose of investigating the losses and proposed remedies in connection with the extraction of tin from its ores. Mr. W. H. Trewartha-James, on a recent occasion, estimated that the value of black tin actually produced in Cornwall and Devon in 1913 was worth over £1,000,000, and, assuming a loss of only 30%, this in round figures amounts to £460,000. Although these figures are naturally of a speculative nature, they serve to emphasize the loss of revenue which Cornwall and Devon suffer owing to the incompleteness of known methods of extraction.

At the present time there are two different schools of research having the improvement of extraction in view. On the one hand, we have investigators trying to improve water concentration. In this connection we have had methodical and scientific investigations as to the losses of tin owing to sliming, notably by the late J. J. Beringer, whose researches were presented in a classic paper before the Institution of Mining and Metallurgy. Various other interesting communications have from time to time been made to technical societies and in the press, but it may be said that no epoch-making progress has been made in practice or in the plant employed.

On the other hand, we have what may be termed the school of investigators and inventors endeavouring to extract the tin partly by chemical and partly by metallurgical means. It is to this line of research that I refer in this article. In looking into the methods and discussing the respective merits and chances of such proposals, it is advisable at the same time to refresh our memories as to the chief characteristics of some of the compounds of tin which are likely to enter into such processes.

TIN OXIDE.—Although there are two oxides of tin, namely, SnO and SnO_2, we need only consider the latter. The mineral cassiterite, though familiar to experienced tin miners, has often defied identification and has misled many mining engineers, owing to the fact that it varies much in appearance. But its chemical and mineralogical characteristics are comparatively simple. Tin oxide in a pure state is of a white or straw yellow colour, which on heating changes to transient brown; but as mined, it generally has a brown or black colour. It crystallizes in the tetragonal system, often with twinning, and has a specific gravity of 6·8 to 7·1. Tinstone, as it is often called, is reduced by carbon or reducing gases such as hydrogen or hydro-carbons at a red heat to metallic tin, a method well known to analysts for determining the tin contents of ores. Tin oxide is not attacked by acids, with the exception of concentrated sulphuric acid, with which it forms an unstable compound, $SnO_2 . 2H_2SO_4$, which is easily decomposed by water with separation of SnO_2. On fusion with caustic alkalies, SnO_2 forms stannates, as, for instance, Na_2SnO_3, a compound employed in calico-printing under the name of 'preparing salts.'

We have in the stannates a possible method of extracting tin from its ores, as SnO_2 can be recovered from these salts, or the solutions can be electrolysed with the deposition of tin; though it must be borne in mind that simultaneously with the tin oxide considerable quantities of silica will go into solution when the ore has been fused with alkalies. This would render operations difficult, especially so if the arsenides, sulphides, and other metals are present. For this reason any such processes suggested by past inventors encountered serious difficulties.

While discussing the oxygen compounds of tin, we must refer in passing to meta-stannic acid, which is distinguished from ordinary stannic acid by its insolubility in nitric acid. Meta-stannic acid forms a hydrochloride which is soluble in water, but on boiling gelatinizes even in dilute solutions. Although this compound has no direct bearing upon our problem, yet it is well to be acquainted with its properties when experimenting with tin compounds.

I will now proceed to discuss processes that are based, in the first instance, on the reduction of unconcentrated tin ores by carbonaceous material or reducing gases, either with or without previous roasting. I am not alluding to the ordinary methods of tin smelting, where the concentrated SnO_2 is reduced by carbon to metallic tin, as this operation is carried on at a very much higher temperature than the processes I am considering, with the slagging-off of the silicious matter and bases present. Numerous inventors have started with the idea that by heating tin oxide with reducing agents the tin can be easily obtained in a finely divided metallic state from the crude ore, so that an inquiry into this subject may not be amiss. Almost invariably the tin oxide is accompanied by oxide of iron, and particularly so after the ores have been roasted. If we now look into the thermo-chemistry of tin oxide and ferric oxide we find that, according to Roberts-Austen's book on metallurgy, the heat of formation of SnO_2 is 137·2 and that of Fe_2O_3 is 199·4 (measured in terms of the large metric calorie). It is therefore obvious that the margin of temperature between the reduction of oxide of iron and that of tin oxide to the metallic state by reducing agents is not a very great one, and that for practical purposes both oxides are approximately reduced at the same temperature. In fact, in practice it is found that the iron oxide is reduced to spongy iron at a temperature below that at which tin oxide is converted into metal, and that there is a tendency to form an iron-tin compound. If, as is often the case, the temperature is increased, we at once get an alloy of tin and iron well known to the tin smelter under the name of hardhead, an undesirable compound often containing other elements such as arsenic and sulphur. We see, therefore, that methods based upon the reduction of tin oxide, either by carbon or hydro-carbons, at once lead to complications, if it is intended afterward to extract the finely divided reduced tin by means of acids, or to recover it by one of the flotation processes.

Others have suggested and patented the idea of collecting the finely reduced metallic tin disseminated through the reduced mass by means of liquation. A typical example of this idea is provided by a process patented a good many years ago by McIvor and others. The practical results of McIvor's work, so far as I can ascertain, have been of a negative nature, possibly owing to the formation of a tin-iron alloy, and possibly also to the surface tension of the molten tin contained in the reduced mass.

TIN SULPHIDES. — Tin forms two compounds with sulphur, stannous sulphide, SnS, and stannic sulphide, SnS_2. Stannous sulphide is obtained by melting together tin and sulphur, or by the action of sulphur vapour on finely divided tin, such as for instance tin foil, which takes fire spontaneously when treated in this manner. Monosulphide of tin has a higher melting point than the metal (280°C) and has a specific gravity of 4·9, and is a black crystalline substance. Stannic sulphide is obtained in gold-coloured six-sided tablets or scales by heating together tin filings, sulphur, and salammoniac, and is known under the name of mosaic gold and used in the arts as a bronze powder. It has a specific gravity of 4·425. The hydro-sulphide can be prepared by treating stannic salts with sulphuretted hydrogen. It may here be mentioned that SnS_2, when heated, partly sublimes without decomposition, the remaining portion being split into S and SnS. This property of SnS_2 has been often overlooked by inventors and others dealing with the treatment of tin ores, and it is worth considering whether it would not be possible to base a process on this behaviour of the compound, and purposely volatilize the tin as a sulphide.

Tin bi-sulphide is sometimes found as a mineral in combination with other metals under the name of stannite, of which the ores of the Conrad mine and of the Mount Zeehan mine are typical examples. The Zeehan ores have the composition $Cu_2S.FeS.SnS_2$. These ores are, however, not found in abundance, and are therefore only of passing interest as far as the general problem under consideration is concerned.

Bi-sulphide of tin forms thio-salts with alkalies, of which thio-stannate of potassium, K_2SnS_3, is a typical example. From this compound thio-stannic acid, H_2SnS_3, can be obtained by the addition of dilute acids. Processes aiming at the formation of thio-stannates of tin from ore have been suggested and some experimentation has been done. In conjunction with others I tried a reaction of this kind on complex tin sulphide containing copper, silver, lead, and arsenic. The process consisted in furnacing these ores with sulphate of soda and carbon, and in some cases with the addition of iron pyrite. The mass, after leaching with water, yielded a solution of thio-stannates, leaving the copper, lead, etc., in the residue. The solution, on treatment with SO_2, gave a fairly pure sulphide of tin, which could be easily converted to oxide and finally into metal. Experiments were also undertaken with a view to depositing the tin from these solutions by means of electrolysis, as had previously been suggested by other investigators, but the results were found to be unreliable and inconsistent, owing probably to the presence of impurities and the variation of the sulphur contents of the electrolyte.

While writing of the electrolysis of sulphide solutions, it is interesting to record that the crude tin which is now being produced in the United States, chiefly from Bolivian ores, is to be refined by means of electrolytic processes. In connection with this method it may also be interesting to recall the fact that C. F. Claus and H. S. Sutton took out a patent in 1905 for the refining of crude Bolivian tin, which often carried silver, by means of an electrolyte containing sodium sulphide (Na_2S) in solution, and plant was erected near Liverpool for the purpose of working the process, but they were closed down for reasons which I could never ascertain. Naturally there are a number of other electrolytes which can be used in refining crude metallic tin, but the subject is outside the scope of these notes.

TIN CHLORIDES. — There are two chlorides of tin, namely, the stannous and the stannic compounds, having the chemical formulæ $SnCl_2$ and $SnCl_4$ respectively. Stannous chloride, $SnCl_2$, can be easily prepared by dissolving tin in hydrochloric acid. In the anhydrous condition it has a specific gravity of 2·171, fuses at 250°C, and boils at 606°C. With water it forms a crystalline salt, having the composition $SnCl_2.2H_2O$. Solutions of stannous chloride have a tendency to form oxychlorides on dilution with much water, such as the compound $Sn(OH)Cl.H_2O$; but the compound can again be dissolved by the addition of acids. Oxychlorides of tin are also formed when the solutions are exposed to the action of air, as shown by the following equation:

$$6\ SnCl_2 + 2H_2O + O_2 = 2\ SnCl_4 + 4\ Sn(OH)Cl$$

Stannic chloride or tetra-chloride of tin, $SnCl_4$, is formed when chlorine gas is passed over or into fused metallic tin. It forms a fuming liquid which solidifies at *minus* 33°C, has a specific gravity of 2·234 at 15°C, and boils at 113°C. Its vapour according to Dumas has a specific gravity of 9·1997. The anhydrous compound rapidly absorbs moisture from the air and fumes, and it solidifies with water and is known in this condition as butter of tin. Several hydrates ranging from 3 to 8 molecules of water have been prepared, and the dyers use one having the composition $SnCl_4.5H_2O$. With ammonia it forms a compound known as pink salt, formerly also used in the dyeing industry.

Chlorides of tin have quite recently, as well as in the past, formed a favourite subject for numerous proposals for the extraction of metallic tin from cassiterite. Some inventors have had recourse to previous reduction of the tin to metallic tin, as shown under the heading of tin oxide, and the subsequent treatment of the reduced mass with hydrochloric and other acids. The stannous chloride thus produced must necessarily be contaminated with other elements, which makes the subsequent treatment difficult and complicated. Fractional precipitation by means of various reagents has been suggested and tried, a notable example being the process of the late J. W. Chenhall, who succeeded in the laboratory and on a semi-commercial scale in separating the various constituents of a complex Cornish ore, containing wolfram, copper, arsenic, etc., by leaching with sulphuric and hydrochloric acids after roasting and reducing the ore with coal dust.

Considerable attention has been attracted by a process evolved by Mr. Arthur Richards, which essentially consists in mixing the ore with salt and carbonaceous matter and submitting the mixture to a red heat, with the result that the tin is volatilized as a chloride of tin. I understand that this method was tried on a semi-commercial scale, and that the experiments are still being conducted by Mr. Richards. I am informed that with certain Cornish ores the treatment leaves very little tin in the residue. Mr. Richards has been good enough to give me the following figures: The charge assayed at 35 lb. Sn per ton and the residue after treatment 1·25 lb. The volatilized product, presumably a very basic oxychloride, contained 65% of Sn, which after calcination and washing with HCl was brought up to 74% of Sn. That it did not reach the theoretical amount of Sn (78·6%) is probably owing to some of the dust being carried over mechanically. This process is certainly worthy of careful attention, as such a reducing chloridizing roast as applied to tin ores seems to offer a reasonable solution of the problem. We have, however, to consider that simultaneously with the tin, iron chloride would presumably be volatilized. Unfortunately also chloride of tin, owing to the high specific gravity of its vapour, will not travel far and is difficult of condensation if diluted with other gases. Furthermore, it must be borne in mind that an operation of this sort, in order to be successful, would probably have to be carried out in a muffled furnace or retort. The construction of such a furnace might offer considerable difficulties, owing to the probable necessity of stirring, and the question of high fuel consumption is serious when dealing with 1 or 2% tin ores. Mr. Richards has, however, informed me that he is experimenting in another direction, which may obviate the use of a muffled furnace entirely; in fact he maintains that the chloride which is driven off is at once converted into oxide by the action of light and air. Personally I can hardly agree with this, although it is quite possible that he has to deal with an extremely basic oxychloride of tin. As I have shown above, $SnCl_2$ is easily decomposed by air and water. Assuming that all these difficulties could be overcome, it should be quite easy to smelt the oxychloride or oxide ultimately produced to metallic tin, which, indeed, has already been done with a small quantity produced by the Richards process.

Various other ideas present themselves to the inventor, assuming that the tin could be obtained as bi-chloride in solution; and this should not be difficult even if an oxychloride were formed, as it would only require the addition of some hydrochloric acid to render it soluble. The chloride of tin could then be precipitated by means of a more electro-positive metal, as for instance zinc or aluminium, but the cost of doing this would be considerable if not prohibitive. Then there is certainly the possibility of producing a pure oxide of tin from these solutions, which would be valuable for the purpose of making enamels, but the SnO_2 used for such purposes has to be practically chemically pure. Another method of recovering the tin from the stannic chloride solutions might be an electrolytic one, as it is not very difficult to deposit tin successfully from a chloride solution. This was done commercially for some time by Bergsoe, in Denmark, not in connection, however, with tin ores, but for the purpose of recovering tin from scrap. Naturally in such a process the chlorine given off at the anodes converts the $SnCl_2$ into $SnCl_4$, and this latter compound was employed by Bergsoe for dissolving the tin from scrap, regenerating $SnCl_2$ and thus making a cyclic operation. A process on these lines has recently been tried in connection with tin ores, but the publication of results is not permitted.

FLUORIDES.—In these notes I have attempted to give an outline of what I call the neo-metallurgy of tin, but it has been impossible to think of or mention all plausible ideas and suggestions of the various compounds of tin which present themselves. For instance, the employment of fluorides instead of chlorides has been suggested, on lines similar to the work done by Betts in connection with refining lead. According to the *Engineering and Mining Journal* of May 27, 1916, the American Smelting & Refining Company is employing hydrofluosilicic acid for refining the impure Bolivian tin obtained by smelting. Though appreciating all the possibilities of fluorides, I am inclined to look for developments in the direction of chlorides.

COSTS.—I may point out that the cost of any such processes must be low, as it is known that the actual cost of smelting tin concentrate, apart from metal losses in the slags, is about 30s. to 40s. per ton. Naturally, the returning charge of tin ores must needs vary with the increase in the value of the metal, slag losses being constant. It is obvious that if we put the smelting losses at 3%, with metal at £100 this equals £3, and with the price at £200 it represents £6, which amount the smelter has to add to the cost of smelting in order to make his profit. Assuming now that some chemico-metallurgical process would completely solve the extraction of tin from its ores, we have to consider whether it would be rational to take the ore as it is mined and submit it to some such process. If we assume that we should get a complete or nearly complete extraction, we should have to compare the cost of producing tin oxide by such a process with the cost of dressing plus the assumed losses. Take for instance Dolcoath ore, which yielded say 33·6 lb. of black tin containing 70% metallic, and assume that the extraction had been 66·6% of the theoretical by water concentration. With the price of metallic tin at £160 per ton, a safe average price for the last 10 years, and black tin at £100 per ton, the value of 33·6 lb. of black tin ($1\frac{1}{2}$%) recovered at the above valuation would be 30s. per ton, and the loss by dressing would be 15s. Any chemical process, recovering the tin as an oxide, and endeavouring to compete with the present methods, would have a margin of 15s. plus the cost of crushing, roasting, and concentrating, which latter operations we will, for the sake of argument, put at 5s., making a total of 20s. It is therefore obvious that such a process would have to be carried out at less than 20s. per ton, in order to show better results than the present method. It seems quite possible that this may be done in time. Naturally, if the process were applied to tailing, which often contains as much as 12 to 20 lb. black tin per ton, there is a still greater scope for such a chemical method. Another alternative suggests itself, that is to take out by water concentration the coarse, easily recoverable portion, known in Cornwall as crop tin, and then treat the tailing by means of a chemico-metallurgical process. A still more profitable field would probably present itself for such a process for ores which contain 3 to 5% of tin, such as those which are mined in Bolivia and elsewhere, as presumably the cost of operation would be practically the same for a 1% as for a 5% ore.

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THE MINERALS OF SZE-CHUAN, CHINA

By HERBERT W. L. WAY.

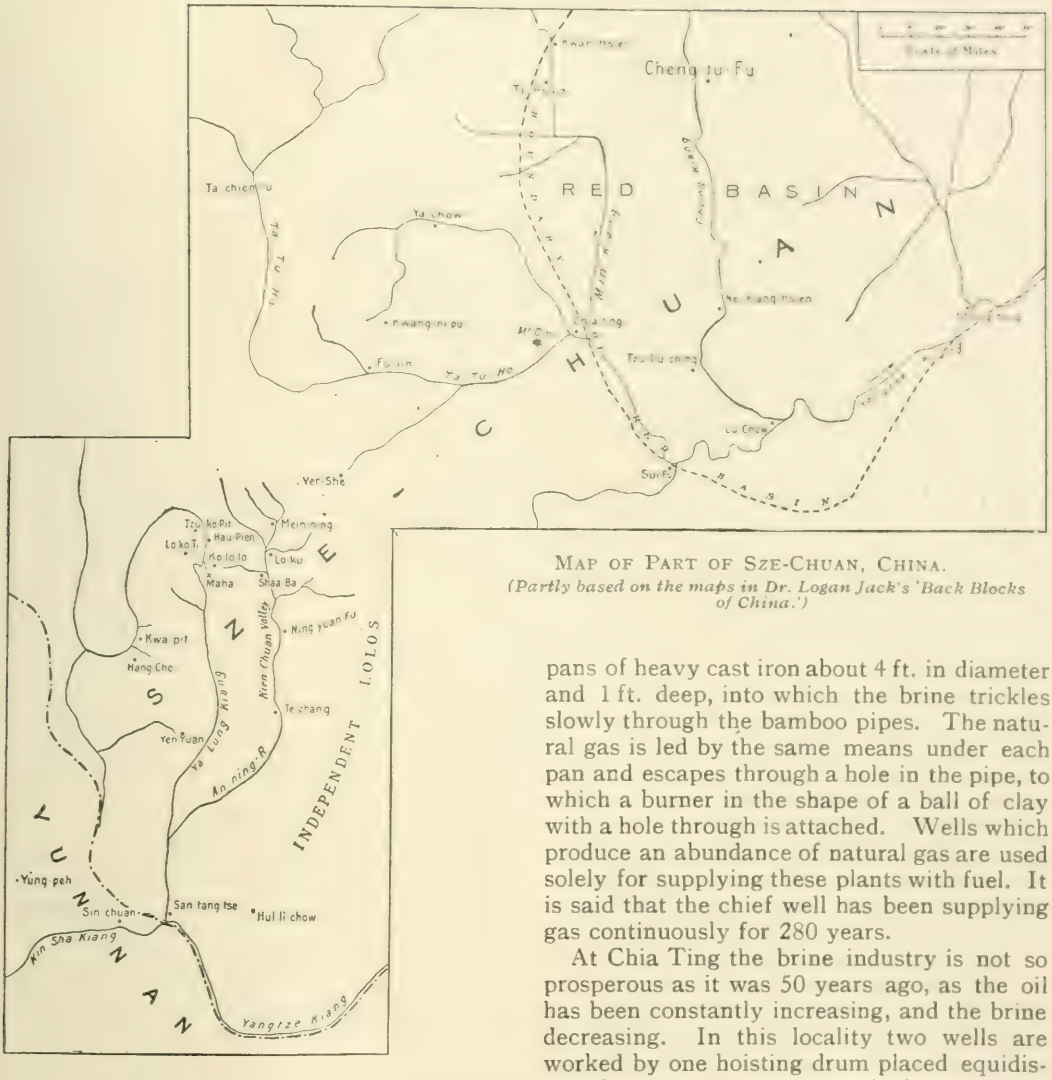
The author of this article has been recently engaged in investigating the mineral resources of Sze-chuan, a province of China that has for centuries been a large producer of metals and salt. Petroleum is plentiful, but has not yet been worked to any extent. Gold, silver, and copper deposits offer promise for development and treatment by modern methods.

SZE-CHUAN is one of the southwestern provinces of China, and it has been famous for centuries for its yield of metals, coal, oil, and salt. Its area is about equal to that of France, and it has a population double that of Shangtung in the north, the next most populous province. Its mineral resources have not often been described, and are little known to English engineers. Having recently made a journey through the province, some notes of my observations may be of interest.

Sze-chuan is roughly divided into an eastern and a western part by the Min Kiang river which flows from north to south. On the west the mountain ranges rise one above the other to 10,000 ft., 15,000 ft., and 20,000 ft., and form the eastern flank of the great Tibetan plateau. On the east lies the Sze-chuan 'Red Basin,' so called from the prevailing colour of the Triassic red shales and sandstones. Here an area 170 by 120 miles, covering 20,000 square miles, consists of horizontal Mesozoic and Tertiary rocks, overlying tilted rocks of the Carboniferous age. Coal and iron are worked extensively in the Carboniferous rocks around the periphery of the Red Basin, and brine and petroleum are obtained by boring within its boundaries. In the northwest part of the Red Basin is the city of Cheng Tu Fu, the capital of the province, a city with 1,000,000 inhabitants. The surrounding plain, known as the Cheng Tu plain, is said to be the most fertile in the world and it supports a population of 4,000,000 inhabitants. Here agriculture has reached a high level of perfection, and opium, tobacco, sugar cane, wheat, barley, rice, peas, buckwheat, oats, and all kinds of vegetables are produced in large quantities. Among the fruit trees are the orange, persimmon, apricot, pear, plum, and mulberry. The plain is irrigated by a complex system of water-courses extending between the Min Kiang and Chung Kiang rivers.

THE RED BASIN.—In the southwest of the Red Basin are the noted brine and petroleum wells of Tzu-Liu-Ching and Chia Ting, which are distant about 35 miles apart. Between these two centres there are from 8000 to 10,000 of these wells, and also some natural-gas wells, the gas being much used by the Chinese. Of the brine and petroleum wells, the most profitable to the Chinese are those which produce the highest percentage of brine and the lowest percentage of petroleum; in fact, a great many wells are closed-down because the percentage of oil is too great for the profitable production of brine. If a well produces over 50% of oil it is considered unprofitable. Those wells that are working produce from 15% to 50% of oil, and 50% to 85% of brine, the average being about 33% of oil and 66% brine. The oil is reckoned by the Chinese as a necessary evil. They hate the touch or smell of it, and it is run out to soak back into the sands, with the exception of a small quantity used for lighting the works. For the latter purpose it is burnt in a crude state in earthenware lamps such as were used by the Romans. At Tzu-Liu-Ching, the chief centre of the industry, there are about 3000 wells from 1700 to 3000 ft. deep, producing in the aggregate 400 tons of brine and petroleum per day, that is 300 tons of brine and about 100 tons of oil, most of the latter being run to waste. The brine is a saturated solution, and by evaporation yields about 25% or 70 tons of clean white salt per day.

These wells take from one to three generations to sink. The shortest time in which a well has been sunk to brine is 30 years. When the brine weakens, the well is sunk a few feet deeper, and the brine immediately strengthens. The wells are sunk by hand for 100 to 300 ft. according to the nature of the rock, and are filled with baulks of cypress timber, which have 6 in. holes bored through them from end to end. These baulks are gradually built up and wedged in place by rock, and the space in the well unoccupied by the timber is filled with clay puddle to keep out the surface water. Afterwards the bore-hole is sunk with a jumping beam having a long iron drill with a chisel bit at the end attached to a bamboo ribbon rope. A high derrick is erected over each well. The bucket for drawing the brine and oil is a bamboo 20 or 25 ft. in length and



MAP OF PART OF SZE-CHUAN, CHINA.
(Partly based on the maps in Dr. Logan Jack's 'Back Blocks of China.')

4 to 5 inches in diameter, with a valve at the bottom. This is hoisted by various methods, but usually by winding the rope round a large vertical drum 20 ft. in diameter. The drum is rotated by 6 or 8 buffaloes, or at some wells by mules or oxen. After the bucket is hoisted, the man in charge puts a hook round the lower end, pulls it over a small cistern, and opens the valve with an iron rod. From here the brine and oil run through bamboo pipes to settling tanks where separation is effected by specific gravity. The oil is first run off, and the brine then pumped by wooden chain pumps through bamboo pipes to the elevated tanks at the various evaporating plants. Each of these plants has about two dozen evaporating pans of heavy cast iron about 4 ft. in diameter and 1 ft. deep, into which the brine trickles slowly through the bamboo pipes. The natural gas is led by the same means under each pan and escapes through a hole in the pipe, to which a burner in the shape of a ball of clay with a hole through is attached. Wells which produce an abundance of natural gas are used solely for supplying these plants with fuel. It is said that the chief well has been supplying gas continuously for 280 years.

At Chia Ting the brine industry is not so prosperous as it was 50 years ago, as the oil has been constantly increasing, and the brine decreasing. In this locality two wells are worked by one hoisting drum placed equidistant between them, the wells being 200 ft. apart, and the drum hoisting the bucket from one well while it lowers the bucket in the other. Otherwise the conditions are the same as at the Tzu Liu Ching.

About 18 miles south of Tzu Liu Ching, there is a seepage where the ground is so saturated with oil that the latter will burn, and there are crevices in the rocks which continually emit gas, which is sometimes set alight by the Chinese.

THE LOLO COUNTRY. — On the western side of the Min Kiang, after passing Ya Chow and entering the mountains to the north and west of the independent Lolo country, are the two prefectures of Ya Chow and Ning Yuen, which cover and area of about 72,000 square miles. From the Chien Chang valley through which flows the An Ning river on the east, to the Tibetan frontier on the west, and from Ta Chien Lu on the north to the Kin Sha river (or river of golden sand) on the south, there is a stretch of country having an area of 40,000 square miles that is without doubt richer in mineral wealth than any other part of China, and one of the most highly mineralized spots in the whole world. This is a region of great disturbance geologically, and it is full of lodes and veins carrying gold and metallic ores. The streams and rivers contain many deposits of alluvial gold. Evidences of mining activity are seen on all sides, and mule trains are seen carrying copper metal and matte, lead bullion, iron, and other metals.

The lodes are worked in a primitive way in the oxidized zones by the aboriginal tribes, some under the supervision of Chinamen. The sulphides are left behind as too refractory. The principal gold mine worked by the Lolos under the Imperial Government and Merchants of Szechuan is the Maha. This contains a wide lode varying from 10 ft. to 50 and 100 ft. The richer ore-shoots average 12 or 14 dwt. of gold per ton, and carry considerable silver, copper, and lead, and the lode from end to end averages 6 dwt. The ore has only been worked for about 20 years, but alluvial gold has been washed from time immemorial by sometimes as many as 15,000 men at a time, both in the valley in which the mine is situated, and in the sands and gravel bars of the Ya Lung river, 4000 ft. below the present workings.

There are extensive native workings on a lode that outcrops beyond the Maha mine on the next mountain, but there the oxidation has not gone so far, and most of the ore is too refractory for the primitive methods of the Lolos, who throw the sulphides, chiefly pyrite, galena, and chalcopyrite, on the dump. The ore selected for crushing is carried by hand over the summit of the ridge to the Ko Lo Lo creek 400 ft. below, where there are 80 stamps worked by 40 overshot water-wheels. Each stamp weighs about 40 lb. and crushes 600 lb. of ore daily in a stone mortar. About 50% of the gold content of the ore is saved by means of quicksilver, which is obtained from a cinnabar mine situated at Hang Cho to the south of Kwa Pit. The amalgam is taken to the Mining Bureau at Shaa Ba, where the miners are paid half its value, as they work on a 50% royalty.

The workings are quite free from water, and as the lode dips with the slope of the mountain, the mine can be worked by adits to a great depth. A new cross-cut tunnel has recently been started, which should cut the vein at 260 ft. from its entrance. The workings on the Maha mine extend for 550 ft. along the strike of the vein, and to a depth of 400 ft. on its dip which is 35° from the vertical. The new adit should open up a large body of ore, and is expected to give at least 1400 ft. of backs below the outcrop.

Four miles north of Maha is the Ko Lo Lo copper mine, part of the workings of which have been carried away in a land-slide. The workings are extensive, and are of more miner-like character than those at Maha. Near the entrance, and in the main adit, is a deep untimbered shaft 6 ft. square, descending in a series of steps, vertical for 6 ft. then a step 3 ft. wide, evidently constructed in that way for passing up ore by hand, and in reality forming an incline shaft at an angle of 27° from the vertical. The mine has not been worked within the memory of man, and no records are in existence at the Mining Bureau. A very large quantity of mineral must have been extracted when the mine was working. The ore visible on the roof of the adit consists of a reticulation of quartz veins containing copper sulphides, carbonates, and sulphates. There are a great number of derelict stone blast-furnaces in the valley below.

The Chinese smelt their copper by the same process as Europeans, but their methods are crude. After stall-roasting the sulphide ores, they smelt in diminutive blast-furnaces, 4 ft. high by 3 ft. wide internal dimensions, built of stone and fire-clay. Each furnace is only good for a 24 hours run, after which it is pulled down and rebuilt for another run a few days after. The blast is supplied by double-acting square wooden bellows, usually worked by hand, though sometimes by water-power. After the ore is reduced, and the slag run off, the molten copper is run into a hemispherical well, and quenched with water.

At Kwang Ni Pu, near Ya Chow, and also at Lo Ku, are iron-smelting works and foundries, treating hematite and limonite ores of high grade, though the extraction is low, averaging 45%. The fuel used, as in copper-smelting, is charcoal, and limestone is used for fluxing. The furnaces are substantially built of hewn stone and fire-clay; 30 ft. high and 5 ft. wide at the tuyeres, widening out to 10 ft. at the bosh, and tapering to a small opening at the top. The tuyere is of sandstone, having a round hole drilled through for the blast. The blast is supplied by double-acting bellows worked by a water-wheel. The iron is cast in thin plates of fine quality, which are broken up and melted in cupolas with hand bellows, and the molten iron is cast in moulds made of kaolin on a wicker foundation. They cast pans for evaporating brine, and cooking pans for boiling rice. The latter are real works of art, being from 20 to 30 inches in diameter by 9 to 12 inches deep, the thickness of the casting being only $\frac{1}{16}$ of an inch at the rim, and $\frac{1}{4}$ of an inch at the base.

OTHER MINERAL DEPOSITS. — So far, I have based my account of the mineral deposits of the province on my own observations. The Mining Bureau contains many other records some of which I quote in the following paragraphs.

The records show that in the Si Chang district there are veins carrying ores of gold and copper. To the north of this at Loku Te Tze are veins carrying gold and lead ores high in silver, said to produce 20 oz. of silver per picul of ore (a picul being 133 lb.)

At Hau Pien, on the Ya Lung river, is an iron mine containing a large body of high-grade ore, which supplies the Lo Ku smelter. West of this, across the Ya Lung river, at Lo Ko Ti are veins of copper ores; this is close to the spot where the Yunnan Company's survey of the railway from Burma crosses the Ya Lung river.

At Tzu Ko Pit, northeast of Lo Ko Ti, there is a rich gold-quartz vein, on the outcrop of which a historical nugget weighing 97 lb. was found. This vein has been worked to a considerable extent by the Government Merchant Co-operative Mining Bureau, who abandoned it because the oxidized ores were exhausted, and from lack of capital to supply means for reducing sulphides.

At Ma Tu San in this district is a vein of silver-lead ore, said to produce 8 oz. of silver per picul of ore. Also a vein carrying silver in the form of argentite.

In the Yung Chang district, southwest of Ta Chien Lu, are numerous quartz lodes and alluvial gravel bars. From Ma Za Han to La Kwan many outcropping quartz veins are known but have never been prospected.

At Ta Chien Lu there are government silver mines producing 5 to 6 oz. of silver per picul. The vein is 4 ft. wide, and is worked along its strike for over 10 miles. This vein contains complex ore carrying copper, silver, and lead, but it is worked only for its silver content.

To the north of Ta Chien Lu is a large auriferous gravel area, situated at the junction of a stream with the Ya Lung river north of Ho Kea, said to produce 13 dwt. of gold per cubic yard.

Near Yer She, at Tzu Ti Di on the Ta Tu river in the neighbourhood of three lakes and hydrothermal springs, there are veins of gold, silver, and copper ores. At Hui Lung Chang in this district there is a vein 6 ft. wide containing copper oxides. At this place 90 smelters worked very prosperously until 10 years ago, when the Lolo Chiefs summoned their men and drove out the Chinese, and have never allowed them to return. But it is not anticipated that any objection would be raised against Englishmen working it.

In the southeast section of the Yer She district veins carrying silver-lead ores are found, and also deposits of bituminous coal of good quality.

In the Ya Chow district at Lu Shan there are the best coal seams in the two prefectures, and also a stratum of calcareous conglomerate impregnated with native silver and horn silver. South of the Kin Sha river at Fu Kean, the limit of navigation, on the range facing Liu Po, there are numerous veins containing copper and silver ores. These mines supplied the greater part of the silver used in the Tang dynasty. This property is outside the two prefectures, but is included in the copper monopoly.

Near Hui Le Chow are numerous veins of gold, copper, and silver ores, which are worked extensively by the aborigines, especially the Ta Tung Chang (prosperous silver mine) and Ta Whan Shan (10,000 jewel mine).

At Kwa Pit there are extensive alluvial deposits rich in gold, and well situated for hydraulic sluicing, especially in the Wei Li To Tze nine miles distant.

In the Yen Yuan district are veins containing gold, silver, lead, copper, and zinc, and also quicksilver. There is a quicksilver mine also at Hang Cho south of Kwa Pit. This is worked by native miners, who supply the Maha mine with quicksilver in lieu of royalty. This mine also supplies the Chung King vermilion works with cinnabar.

In the Kwa Pit district there are extensive alluvial gold deposits, well situated for hydraulic mining, especially at Wei-Hi-To-Tse, nine miles from Kwa Pit.

In concluding this sketch of Sze-chuan, I may say that the higher plateaux and slopes of the mountain ranges are well wooded with trees useful for their timber, besides pine forests in which the Chinese have movable match factories.

PRECIOUS STONES IN THE URALS

By C. W. PURINGTON.

The Ural mountains are noted not only for gold, platinum, and copper, but for many precious and semi-precious stones. Here deposits are found containing emerald, spinel, garnet, tourmalines, zircon, chrysoberyl, etc. The author describes in particular the Great Reft River emerald deposit.

THERE are in the vicinity of the city of Ekaterinburg in the Ural mountains certain deposits of rare minerals, among which some rank as precious and semi-precious stones. The region of the northern Ural has long been known as one of the most remarkable mineral localities in the world. Those deposits which contain the precious minerals lie principally to the north and within a distance of 100 miles of Ekaterinburg, as shown in the accompanying map. The most important of these are situated at a distance of 25 miles directly north of the town of Bazhenova, which is a station 50 miles east of Ekaterinburg, on the Perm-Ekaterinburg railroad. The old workings lie in a north-north-west line along a distance of 12 miles, and an old and little-used log-road connects the mines with Bazhenova.

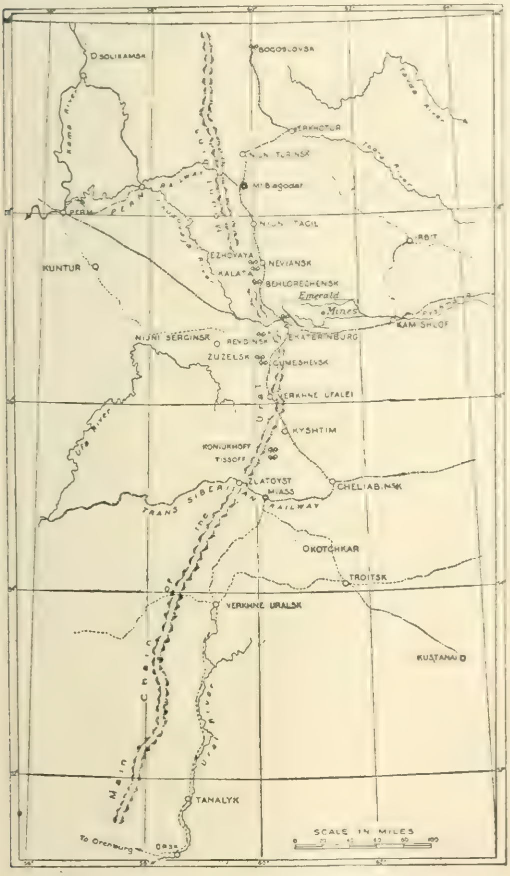
It is difficult to arrive at the exact history of these deposits. The most important precious mineral produced from them appears to have been beryl, the darker-coloured varieties of which are known as emerald. The Bazhenova deposits produced beside chrysoberyl, staurolite, and rarely the corundum minerals, in small quantity. At a distance of a few miles to the west there exist deposits of minerals, among which quartz crystals of the variety amethyst occur, also topaz and olivene. Other rare minerals occur with these, but in quantities relatively insignificant. Farther south on the line of the trans-Siberian railway, in the vicinity of the town of Miass, in the Ilmen mountains, occur the renowned deposits of ilmenite, zircon, spinel, etc. These have not been shown to have more than a scientific value. In the vicinity of the town of Zlatooust, on the Siberian railway, small deposits have been worked for precious stones. These occur as segregations in a metamorphic chloritic schist associated with diabase. The minerals sought are tourmaline, perofskite, spinel, garnet, and apatite. Much calcite occurs here as gangue.

The Great Reft emerald deposit is the most important deposit of all. As the Ural precious-stone deposits are on land that belongs directly to the Cabinet of the Russian Emperor, they have not been worked systematically for seventy years, which is the period which has elapsed since the Crown ceased working. This is known to be the case with the beryl and emerald deposits on the Great Reft river. They were formerly worked by slave-labour, and after the period of the freeing of the slaves, the working of the deposits was apparently not found profitable to the Crown. This was also the case with the gold-mines of Berezov, immediately to the north of Ekaterinburg. In the case of the Great Reft deposits it seems strange to one who traverses the line of old pits that such poor mining could have paid at all, however rich the deposit.

The region is nearly flat, well wooded and swampy. The Great Reft river, which crosses the deposit at its southern end, has about 50 second-feet of water, roughly estimated.

The rocks of the immediate vicinity to the Great Reft are of igneous origin. Granite is found to the west, forming a part of the immense granite area to the north of Ekaterinburg, to a portion of which Karpinsky has given the name beresite. To the east is a large diorite area. The rare minerals which give the deposit a scientific and an economic value occur in what is now a compact biotite schist having an extent of about 12 miles north to south, and so far as is known a width of about 800 ft. As far as the exposures permitted an examination of the rock in place, the schist appeared to be in contact on its west side with a quartzite, having all the appearance of a metamorphic and silicified sandstone. The strike of the schistosity is N32°W, and the dip is sometimes vertical, sometimes rather steep to the west. This is also the direction of the line of contact between the schist and the sandstone. The emerald, beryl, chrysoberyl, and other rare minerals occur as single crystals, sometimes very close together, in the schist, with whose leaves of mica they are closely interlocked. In the schist, and likewise to a less extent in the sandstone, occur gypsum, talc, chlorite, serpentine, and other minerals characteristic of metamorphic rocks, while the biotite, especially in contact with the emerald crystals, is often so bleached as to resemble sericite. The emeralds obtained are badly flawed, and it is rare that one of great value is found. The colour is frequently rich and dark. It seems to be the case that those having the best colour are most filled with impurities.

The field evidence appears to point to the conclusion that the belt of biotite schist is a metamorphosed dike of basic character, possibly peridotite, but more likely an olivene-gabbro, or diabase, and that it was the sudden cooling, in contact with the sandstone, of this mass of igneous rock that produced the rare minerals along the contact. Such a conclusion is borne out by the fact that the phenomena of mineralization are the same along a distance of 12 miles, along which distance also the sandstone and schist are constant in occurrence and relative position.



MAP OF THE SOUTHERN URAL MINERAL REGION.
The Great Reft emerald mines are situated about 60 miles northeast of Ekaterinburg.

A few miles to the west of the Great Reft river, there are several deposits of rare minerals, in the large granite area, and they are of fumarolic character for the most part. Pegmatitic segregations in the granite are not uncommon, and the characteristic minerals of these deposits, tourmaline, tinstone, topaz, wolframite, etc., occur. The deposits are limited in extent and of stock-like form. This granite is also everywhere characterized by the presence of olivene in large amount, and in certain localities crystals of olivene attain sufficient size and clearness to be ranked as semi-precious stones, chrysolite.

The old workings in the emerald and beryl deposits of the Great Reft river consist of a number of old pits, shafts, and open-cuts, of which perhaps only 10 or 12 have been sunk to any considerable depth. These openings are all on the schist belt, and stretch a distance of 12 miles from south to north along the strike of the schist. The deepest shaft was sunk only to 135 ft., and it is stated that on the Stretenski mine a tunnel 580 ft. in length was run on one of the leads. The shafts, now entirely abandoned and filled with water, show the poorest construction, being often sunk in the bottom of small pits, no opportunity for a dump being allowed. The largest single working appears to have been an open-cut on the Tokofskoi mine, which cut is 700 ft. in length, 300 ft. in width, and 40 ft. deep. That much ground was worked is evidenced by the large amount of tailing in the dumps. These dumps are at the present time being re-worked by the peasants, who operate each for himself on a permit obtained from the office of the Cabinet in Ekaterinburg.

The precious minerals appear to occur in more or less well-defined shoots or leads in the schist. These shoots vary from 1 ft. to 8 ft. in width, and are sometimes 500 ft. or 600 ft. in length. Whether or not these shoots have a well-defined distribution I do not know, as the present exposures are too limited to determine this point. The chrysoberyl, of which the precious variety is known as alexandrite, is mostly found at the southern end of the belt of schist. Its amount is, however, in small proportion relatively to the occurrence of the beryl. Mining conditions must have been expensive, since the sinking of shafts would necessitate much pumping in this district.

I understand that since my visit to the Reft mines an attempt was made by a French company to operate them, but from the flawed character of the gem occurrences, it is not likely that any great amount of commercial success would result from the undertaking.

DE LAUNAY ON RAND GOLD

By DAVID DRAPER.

De Launay's theory of the origin of the gold in the Witwatersrand conglomerates was enunciated twenty-five years ago, but has suffered eclipse by the placer and impregnation theories. De Launay's views are here revived. They deserve attention because, in the present author's opinion, fewer objections based on geological experience can be urged against them than is the case with the other two theories.

SCIENTIFIC investigation on the spot by several of the leading authorities on ore deposits quickly followed the discovery of the auriferous conglomerate beds of the Witwatersrand. Naturally the genesis of the gold was one of the most important subjects to occupy the minds of these scientists, for here they found conditions quite foreign to any known occurrences of the precious metal. Many theories were advanced, but of these only three have survived:

(1) The placer origin of both the conglomerates and their gold contents.

(2) The contemporaneous chemical deposition of the gold with the pebble beds.

(3) The impregnation or enrichment of the beds after they had solidified.

Professor G. F. Becker advanced the first, and L. de Launay the second. The author of the third is not recorded, but probably J. S. Curtis is entitled to the credit. Whoever he was, he was supported by a large number of authorities; in fact, until quite recently the third hypothesis was the only survivor of the three theories. No. 1 theory was revived by Dr. J. W. Gregory a few years ago, and by Dr. E. T. Mellor in February, both of these authorities enunciating their views in papers read before the Institution of Mining and Metallurgy. De Launay's hypothesis was ignored in the discussion which followed the reading of Dr. Mellor's paper by everyone except myself, yet I submit that the hypothesis is worthy of much greater consideration than it has received. I have therefore ventured to trespass on your space by giving extracts from his original paper* as well as from the writings of his opponents, adding a few observations of my own, hoping by this means to revive interest in a theory that to my mind affords fewer impossibilities regarding the origin of the gold than any of the others.

After describing the special geological features of the Witwatersrand conglomerate series, in the area extending from the Nigel mine to Klerksdorp, De Launay, in his paper, discusses the question regarding the position and gold contents of the conglomerate beds as follows:

"The auriferous formations of the Witwatersrand have often been described as filling an ancient lake, of not very extensive area. The shores of the lake have even been mapped out, following pretty closely the present outcrop from Klerksdorp to Johannesburg and Heidelberg. In connection with the same hypothesis, reference has been made to deltas formed by torrents, but the writer's opinion does not accord with this hypothesis. The deposits have none of the characters of lacustrine formations which the writer has had occasion to study very closely in connection with the coal measures and Tertiary lakes of the Central Plateau of France. They have all those of a great marine formation, whereof the conglomerates form the littoral facies, here considerably developed.

"Leaving out of account for the present the auriferous impregnation, which does not necessarily characterize the whole of the geological formation of the conglomerate in which it occurs, nay, which must be considered less than co-extensive with it, the writer considers that the series of quartzites and conglomerates of the Witwatersrand forms a great synclinal fold, striking northeast-southwest between the two lines of outcrop (the one from Modderfontein to Buffelsdoorn, the other from Nigel to Heidelberg)."

Accepting the granite north of Johannesburg as the site of the anticlinal axis, De Launay deals with the tilting of the Witwatersrand series in the following sentence:

"It is not easy to say whether the granite is anterior or posterior to the series of conglomerates, but the entire metamorphism of the whole of the Witwatersrand series would lead one to infer that the granite is of later age."

With regard to the reef structure he says:

"The gold ores of the Witwatersrand are made up primarily of conglomerates, and quite secondarily of coarse grits and quartzites, with more or less rolled quartzose constituents, cemented by a silicious matrix wherein are scattered small pieces of quartz, and which contain veins of pyrite, a mineral with which the

* Gold Mines of the Transvaal, by L. de Launay. Transactions Fed. Inst. Min. Eng., Vol. XI., page 391, 1896.

gold always appears to have been associated. The dimensions of the rolled constituents may vary enormously from one auriferous bed to the rest, and the question of size gives no reliable indication of the richness of the gold. Nevertheless, in a given bed, corresponding to a particular period of deposition, and above all at a particular spot in this bed, it is possible to assert that gold segregates in association with the biggest constituents, that is, with those whose displacement by the waves necessitated the largest amount of force. This holds good with the conglomerates properly so called, and also with fine-grained conglomerates and quartzites.

"But a not unfrequent occurrence a few feet away from an ordinary quartzite, or from a small-pebble auriferous conglomerate, is an absolutely barren bed with big pebbles. Moreover, two neighbouring bands with pebbles of exactly similar size may differ greatly as regards their gold contents. Of this fact, the Main Reef and the Main Reef Leader, beds which are generally close to each other, yield frequent proof. The Main Reef, with pebbles as big, often bigger than those of the Leader, assays almost invariably at a much lower grade.

"The ore which is by far the most frequent occurrence, especially in the mines of the Central Rand, is a conglomerate with pebbles varying in size from a hazel nut to a hen's egg.

"The association of the gold with the conglomerate is explicable on either of only two hypotheses, which can account for the incoming of the precious metal. If the gold was drifted here as in a placer, or if by any conceivable means there was some kind of transportal, it seems quite natural that the metal should be associated with such fragments as are less easily carried off by water, not so much on account of the specific gravity as on account of the dimensions. This description applies to the pebbles, while the fine grains of sand were being carried away. If on the other hand the gold is simply the result of chemical precipitation contemporaneous with or later than the rest of the deposit, the percolation of auriferous solutions must have been much easier amid the wide interstices left by the big pebbles than amid closely compact sands with few penetrable interstices.

"With reference to the pyritic content of the conglomerates, the gold is mechanically associated with it, because the latter is entirely soluble in potassium cyanide, and that, in saying in a general way that the gold is associated with the pyrite, means that it was deposited at the same time by a coincident phenomenon.

"The pyrite is often rolled and more or less broken in the grain, showing that subsequent to its crystallizing out, it must have undergone driftage for a short time. The pyrite occurs in zones, either parallel with or oblique to the bedding, such as one sees in all sedimentary deposits. On the other hand, crystalline pyrite, either isolated or in secondary groups at times moulded on to the quartz grains, is also of frequent occurrence. This may be attributed to a secondary crystallization, or to chemical precipitation *in situ*, which then excludes the question of driftage. Moreover the pyrite is only stratified in rare cases; seldom indeed is it met with in the form of a layer or band, but it is scattered in every direction amid the mass of conglomerate from top to bottom, in defiance of all the rules observed in alluvial gold deposits.

"Frequently the pyrite forms a sort of crust round the pebbles. This would lead to the inference that the surface of the pebble had a precipitating action upon the pyrite similar to that observed in all pebble filters through which metallic solutions are passed.

"These various facts which will have to be taken into account, coupled with the fundamental observations that the pebbles do not contain gold, point to the conclusion that the formation is the result of something else than merely transportation and erosion of material derived from quartz veins.

"The hypothesis of the contemporaneous formation of the gold and the sediments presupposes the existence of a beach, whereon fragments of quartz (where originating is a matter of little consequence) were ground down and rolled by waves, and here lay gold and iron sulphide brought perhaps by some agency connected with vein formation. The sulphides would also be in solution in the water. They were then precipitated chemically rolled *in situ* by the waves, and they would finally have been deposited pellmell with the pebbles.

"In order to account for the characteristic circumstance that the gold is almost entirely restricted to the conglomerates, and hardly occurs at all in the intervening sandstone (quartzite), one must be prepared to admit the influence of some mechanical agency directed to the commingling of the gold and the pyrite or heavy constituents with the larger pebbles. On this hypothesis it becomes easy to explain the presence of crystalline pyrite side by side with rolled pyrite, either by recrystallization or rather by the fact that a number of pyrite grains will have been precipitated direct, and will have escaped the wave actions. Nor is there any reasonable objection to the supposition that waters charged with metallic salts may have permeated the beds previously deposited and covered by the sea. These waters no doubt infiltrated more readily through the larger interstices between the big pebbles and precipitated the substances held in solution on to them. Neither is the precipitation of gold from solutions difficult to realize, and there is no necessity for invoking the presence of a reducing agent in the shape of organic matter. Gold is precipitated by all manner of agencies, and the only difficulty is which to choose among them all.

"Finally the primary origin of the gold may be ascribed either to thermal springs holding gold and silica in solution, such as those which caused the formation of auriferous vein quartz, or, if one will, to the erosion of veins of this kind, followed in the present case by chemical solution instead of being the result of mechanical agencies."

The writers mentioned in the opening paragraph inspected the goldfield about the same time. Curtis was then and still is a resident of Johannesburg. They saw the outcrop lines of the banket beds where they probably closely presented their original characteristics. The conglomerate layers were represented by pebbles loosely held together in the cementing matter, and not as they now appear in a compact, dense, hard rock. The deepest mine working was less than 1000 ft. from the surface, though the Rand Victoria bore-hole had penetrated to the Main Reef at 2352 ft. But the writers adopted divergent views on the question of deposition of both the beds and their auriferous contents.

When Becker published his report* he did not neglect the opportunity of criticizing De Launay's theory in the following terms:

"The precipitation theory is by no means free from objections, chief of which is that it gives no account of the most important feature of the deposits, namely, the association of gold in largest quantity with the coarsest banket. One would expect to find the sands at least as much mingled with the auriferous precipitate as with the banket. Precipitates are usually thrown down in a fine state of division. How is it, then, that the currents which swept away all mud and fine sand did not carry off the crystals of fine gold and pyrite before they had time to reach considerable dimensions? De Launay supposes a relatively quiet deposition of the gold and pyrite from sea water in unsorted material followed by a natural process of concentration. I perceive no opportunity for supposed quiet precipitation of gold and pyrite, nor do I understand why precipitation, if it takes place at all, does not continue during the sorting process, so that the sands, eliminated from the pebbly material, could continue to be enriched by precipitates.

"The fundamental hypothesis of a sea highly charged with gold and pyrite seems to me impossible. Had the ocean at any time been so charged, the mineral would, as Mr. de Launay states, be precipitated with extreme ease. How then could the ocean be so charged? It would seem that the gold and pyrite going into solution, say at the mouth of some Silurian solfataric vent, must be thrown down almost immediately and close to the point at which solution took place. A uniform distribution of gold along a coast line known to be 30 miles in length would thus be impossible. Again, if the ocean were so powerful a solvent of gold, why are there not many and indubitable cases of deposits formed by this method?"

Other writers on ore deposits have passed their opinions from time to time since the original theories were published. The majority support the impregnation theory. In reviewing these opinions I am struck by the small amount of space they devote to De Launay's hypothesis and the weakness of their arguments against it.

Lindgren* disposes of Becker's and De Launay's theories by simply stating that "they are both untenable," nor does he support the impregnation theory, or suggest a substitute.

Hatch and Corstorphine† object to De Launay's theory, because "it pre-supposes waters rich in dissolved gold, and the occurrence of some chemical change at a time when waters were disturbed by movements capable of covering the formation by fairly coarse sediments. One naturally associates the growth of crystals with quietude and not with violent disturbances of the water in which they were supposed to be formed."

The latest writers, Beyschlag, Vogt, and Krusch‡ do not agree with the placer or alluvial theory, and object to De Launay's principally "on the assumption that the gold contents of the sea were not sufficient, and that in the laboratory it is not possible with the agents

*G. F. Becker. United States Geological Survey. Eighteenth Report, 1896-7, page 173.

*'Mineral Deposits,' Page 222.

† Witwatersrand Conglomerates, *Trans.* Geol. Soc. of S. Africa, Vol. VII., pt. 3, 1904.

‡ 'Ore Deposits,' Page 1159.

present to precipitate gold from such dilute solutions; very energetic assistance is required to bring this about."

Beck and Weed* state: "The gold particles have no resemblance whatever to mechanically transported gravel gold, neither is the distribution in the reefs such as is customary in gravels. De Launay's theory is negatived for the following reasons: precipitation ought to have taken place in the sand furnishing the quartzites, and the exceedingly slight gold contents of the present seas do not suffice."

Recent experiments of J. R. Don show that not one of the reagents occurring in nature was found by him capable of effecting a precipitation of gold from sea water, and concludes by stating that "the impregnation hypothesis seems as yet to present the greatest probability, though the question is by no means settled."

Having been engaged in geological and mining operations on the Witwatersrand during the last 28 years, perhaps my own observations may assist in elucidating some obscure points in the deposition and gold contents of the Rand conglomerates. I have found, as the result of many thousands of assays, the whole series of conglomerates and quartzites to be auriferous to a greater or less extent. Even the lower portion of the series has yielded payable patches in different parts of the country. I may instance the Ivy mine in Barberton district, and the Abelskop in the Western Transvaal, both of which are situated on the Hospital Hill slate beds; and there are patches of similar slate in Troyeville which yield high assays. Many quartzite layers, utterly devoid of pebbles, show rich assays, and from one of these I obtained 60 ounces of gold from 100 tons of rock. The difficulty of following an undefined layer caused the abandonment of this high-grade prospect. Sawyer obtained gold in over 500 assays taken from cores on the New Rand, and he did not come across a single actual blank.

In the majority of the pebble beds the gold is very unevenly distributed; patchy but blank pannings are few and far between. Rich patches have been worked on many of the reefs both over and under the Main Reef series. For instance the Ida mine on the Kimberley reef; the Rietfontein on a detached portion of the Elsburg series; the Buffelsdoorn and Gold Estates both situated on the Elsburg series; and the Ada-May in Klerksdorp, probably on the Kimberley series. The Bird Reef on Langlaagte yielded 10 dwt. per ton in a trial crushing at the Paarl Pretoria mill, of which I was manager in 1888. Over a thousand tons was treated with the above-mentioned result. The difference between the Main Reef leaders and other pebble beds is more in the continuity of the rich patches, or their more frequent occurrence than in any other characteristic. There are, however, many low-grade patches in the leaders of the Main Reef series, for instance on the Bantjes and the Aurora group of mines; in fact, westward of the Langlaagte creek the Main Reef series is poor compared to the central and eastern section.

The Main Reef itself is generally very poor though it consists of a much coarser conglomerate than the rich leaders which accompany it. From a test crushing of 3000 tons, I obtained a return of under 4 dwt. per ton. The richest part of the reef in this instance lay near the hanging wall. From a narrow leader about 100 ft. higher in the series, 10 ounces per ton was recovered in the Paarl Pretoria mill.

There is no evidence obtainable in the workings to assist the miner in following up a rich patch, other than the gold contents. There is no evidence of feeders or enrichment due to faulting or the intrusion of dikes. Though there are isolated cases of enrichment in the vicinity of two or three dikes, these have been ascribed by Mellor and others to different causes than the action of the dikes themselves.

Though patches of nuggety alluvial gold were found at several places on the Rand, notably at Witpoortje and near the Klipriversburg at Johannesburg, these were superficial and recent. A few nuggets were found in the Rietfontein series, actually taken from the conglomerate bed at a depth of at least 300 ft. from the surface. Those nuggets may have been formed chemically, a possibility in accord with the experiments of Egleston, Wilkinson, Cosmo Newberry, Skey, and others, details of which are given by Warnford Lock in his book on 'Gold,' published in 1889.

Personally I have been unable to trace any resemblance to placer deposits in the auriferous conglomerates of the Witwatersrand.

On one point all the authorities agree, and that is with regard to the possibility of dissolving and re-precipitating gold from solutions. It is also the main argument used by the advocates of the impregnation theory, and even the placer authorities admit that at least a proportion of the gold of the conglomerates has been introduced by these agencies. Several writers have no hesitation in discarding the placer or alluvial origin of the gold. It is in their objection to De Launay's theory that

* 'The Nature of Ore Deposits,' Page 516.

they are exceptionally weak, especially when they object to precipitation from sea water because they are unable to bring about this result from the oceans of today. Just as well might anyone challenge the deposition of the great limestone beds or dolomite of Archæan or palæozoic times from oceanic solutions, because there is not sufficient lime in the oceans of the present time. Or the existence of the iron-bearing beds of Brazil and other parts of the world because there is not sufficient iron in solution at present. By far the greater proportion of the metallic contents of the earth's crust are situated in pre-Carboniferous rocks. From these we obtain vast quantities of iron, copper, silver, lead, the bulk of our gold, and many other valuable ores and minerals. The conditions necessary for deposition, crystallization, solution, etc., of mineral matter, must have been far greater and the operation must have been more active then than at any subsequent period of the earth's history; and these factors alone would suffice to increase the mineral contents of the oceanic waters held in solution. Then again no doubt chemical operations were intensified and accelerated by higher temperatures in general or by volcanic activity in certain areas and the consequent heat of the water which laved the shores of some of the primary land-surfaces.

Supporters of the placer theory see no difficulty in contravening the laws of gravitation, by assuming that metallic gold can be transported by water for long distances. They have no hesitation in imagining the existence of a local rock series from which the detrital matter forming the conglomerate beds has been derived, though there is no geological evidence to support their views, and they do not stick at even defining the direction of the flow of streams which formed the deltas or lake basins. Supporters of the impregnation hypothesis look upon the dense impermeable quartzite as a permeable bed, through which auriferous solutions introduced by non-auriferous basic igneous dikes could travel freely and deposit their metallic contents as they would in a porous rock, but when discussing the possibility of the contemporaneous deposition of the conglomerates and their gold contents they resort to evidence which to my mind is unconvincing. De Launay's hypothesis requires no violent straining of well known natural laws. Gold is soluble, and in this condition may be transferred far beyond its point of origin by flowing water. It can be deposited by suitable reagents, re-dissolved and re-deposited, whenever the necessary conditions are sufficiently favourable. These points, I venture to suggest, are indisputable. The question arises: did those conditions exist in the early history of our sedimentary formation? Many authorities answer the question in the affirmative, but others consider it as highly improbable though not impossible.

Mellor has shown that stagnant water is not an essential factor in the deposition of metals in solution. There are instances of veins being formed at the present in fissures from which streams issue. The abrupt alternations of conglomerate beds and fine sediments in the Witwatersrand beds indicate periods of movement and quiescence in the waters in which they were being formed. Becker's argument that "the currents which swept away all mud and sand should have carried away the crystals of gold" can be contradicted by anyone who has handled a gold-digger's pan, and his contention that "a uniform distribution of gold along a coast line known to be 30 miles in length would by De Launay's hypothesis be impossible" is the strongest argument against his own (placer) theory that has ever appeared in print. With regard to higher temperatures in primary or Archæan times, Lyell* states that the evidence favours the opinion that the heat was generally in excess of what it now is. The total absence of fossils in the Witwatersrand beds, and in fact in most rocks of similar type, such as the itabarites of Brazil, which resemble the Lower Witwatersrand beds, may have resulted from the high temperature of the oceanic waters in which they were deposited. Local enrichment of beds would, by De Launay's theory, be influenced more by the precipitating action of the reagents than by the actual amount of gold in solution, and by concentration or washing away of the lighter material, in addition to the mineral contents of the oceanic waters.

Taking these points into consideration, I submit that De Launay's theory appeals more to common-sense views of this interesting subject than any other. At the same time, those who are doubtful as to the continuity of the present values to far greater depths than those at present attained, will see in it less cause for apprehension than the other theories afford. Placer gold beds are notoriously local and irregular in their yield, and impregnation deposits if possible even more so. On the other hand, chemical deposition contains the elements of continuity which are wanting in the other hypotheses.

* 'Principles of Geology,' Vol. 1, Page 231.

DISCUSSION

East Pool Exploration.

The Editor:

Sir—The concluding sentence of the article 'Cornish Mines during 1915' contributed by my friend Mr. B. Angwin in your April issue, is liable, in my opinion, to convey the idea that the plan recently devised for attacking the northern ground of the East Pool & Agar property was an entirely new one. May I, as the manager of those fine old mines, before Messrs. Bewick, Moreing & Co. took control, say that such an impression could never be wider of the mark. I give my reasons for these assertions in the following remarks.

Many years ago, when East Pool and Wheal Agar were separate mines, the cross-cut north of the East Pool old shaft was extended beyond the 'Great Lode,' with the object of intersecting another lode, formerly worked in the eastern section of the Wheal Agar sett, but the boundary was reached without meeting anything of value. Then the late Captain Bishop commenced cross-cutting north of the New North lode on the 200 fathom level, at a point a considerable distance west of the shaft, which position permitted a much greater distance north to be traversed. He also went to the boundary, and so keen was he on the prospect that he even ventured some distance into the Agar sett, but the result was disappointing. Years afterward, in 1908, when I became manager, the East Pool & Agar United Mines were almost derelict. However, I made a study of the geological conditions of the district. This, together with the knowledge gained while running the mines, convinced me that if the mines were to be saved, cross-cutting north must be resumed, in hope of finding further orebodies in this unexplored ground.

I need not trouble you with the deductions upon which I based my convictions. Suffice it that the results have proved successful.

Although we had at this time to build practically a new mill, and very many other costly preparations had to be made, including the bridging over of the 'gunniss' of the Great Lode at the 160 fathom level, and that of the New North lode at the 240 fathom level, to say nothing of the expensive stulls below to hold waste rock from these developments, with encouragement from the late J. H. Collins and the other members of the committee, cross-cutting operations were actually commenced; but owing to lack of capital, and the more immediate necessity for other developments in order to supply the mill, they had, much to my regret, to be temporarily suspended, until such time as capital could be found for the resumption of this work. Later, through the untiring efforts of Mr. J. M. Holman, Mr. H. M. Rogers, and the committee, a plan was matured, as you know. I immediately resumed cross-cutting, and I continued this until I severed my connection with the mines.

I could say a great deal more as to my opinions and my experience regarding the northern ground, but fear to unduly encroach on your space.

JOSEPH JENNINGS.

Pigg's Peak, Swaziland, May 29.

Nigerian Tin Deposits.

The Editor:

Sir—In the interesting article by Mr. H. E. Nicholls on 'The Nature of Nigerian Tin Deposits' in your last issue there are two points, one of considerable geological interest and the other of no less economic importance to the future of Nigerian tin-mining, which, in my opinion, are open to criticism.

The first is the ultimate origin of the cassiterite, and the second is the question as to whether the alluvial tin has been re-concentrated from older deposits or has been derived directly from the tin-bearing rocks.

In regard to the first point, the ultimate origin of the cassiterite, I quote the following passage from Mr. Nicholls' article: "A natural explanation of this is the absence of quartz in any appreciable quantity in the granites which are the source of the alluvium. A curious feature is that when quartz stringers do occur they are barren . . . . . ." If, as it would appear, it is intended by this to imply that cassiterite found *in situ* does not occur in conjunction with quartz, then such a statement is contrary to my own experience. I have never seen tin *in situ* in Nigeria except in highly quartzose variations of the granite magma. This is not to say that all quartz veins carry cassiterite, but that where cassiterite is found it is invariably accompanied by quartz, greisen, or pegmatite.

The following occurrences exemplify this:

(1) The quartz and greisen deposits on the N'Gell lode area.

(2) The quartz and greisen lode opened up by the West African Mines at Bukuru.

(3) A small stockwork of quartz veins between Nos. 4 & 5 streams on the N. N. Bauchi area.

(4) The Kano Tin Areas lodes.

(5) The Jemaa greisen and pegmatite.

Present evidence, as far as it is forthcoming, is all in favour of the usually accepted theory in regard to tin deposits, namely, that they are due to after-actions of the cooling granite, during which period the segregated highly-silicious magma, carrying stanniferous and other minerals, is injected into the semi-plastic rock.

As to the second, and economically more interesting, point in Nr. Nicholls' article to which I think objection may be urged, the question as to whether the alluvial tin is derived from older deposits, may I briefly set out Dr. Falconer's theory ('The Geology and Geography of N. Nigeria') as I understand it.

Dr. Falconer supposed the granite of the plateau to have been decomposed to great depths in former periods when the climate was very different from what it is now, and when the plateau formed part of the present Zaria plain; subsequently the plateau was elevated to its present position and the decomposed granite was disintegrated, washed away from the higher ground, and spread over the greater part of the plateau as a detrital or eluvial deposit. This deposit Dr. Falconer calls 'drift.' The tin in the decomposed granite would naturally be to some extent concentrated in the drift, and again re-concentrated in the more recent streams and rivers, which cut their way down through the drift and form the present river beds and alluvial flats.

Now Mr. Nicholls in his paper thinks the tin has been derived directly from the granite, and though he brings few arguments or instances in support of his view, apparently does not admit that the drift has played any part in the formation of the present alluvial ground. No doubt there are many places where the covering of drift has been denuded and the granite in turn is again contributing to the supply of alluvial tin, but if the presence of the drift is admitted (and as it covers perhaps 80% of the surface of the plateau it can hardly be denied) and if it carries tin (which is also fairly obvious from the numerous workings in it), it follows that quite a considerable quantity of the alluvial tin in the present river beds and flats must have been originally in the drift. Perhaps one of the most interesting instances that I can cite is the headwaters of the Delimi, where the Rayfield Tin Fields are opening up what appears to be an old river channel in the drift. The deposit is about 50 ft. deep, having, under approximately 40 ft. of overburden, about 10 ft. of wash, much false-bedded and with hardly any stones bigger than an inch in diameter, which would seem to indicate that it had been laid down in a wide slow-running stream.

Now the present tributary of the Delimi has not yet cut down through the overburden of the ancient deposit and consequently is not very rich in tin, and owing to that fact the discovery was nearly missed. But certainly the tin that was in the stream must have been derived from the drift, and had the stream cut its way down to bedrock there would then have been formed a river bed and alluvial flats of exceptional richness.

A little farther down stream where the tributary flows through a rocky gorge down on to the flats of Jos Tin Areas, it has cut its way not only through the drift but also into the underlying granite.

Now which is the more likely? Has the tin on Jos Tin Areas been concentrated from the comparatively barren granite, or from the comparatively rich and more easily denuded drift?

Of course to say that alluvial tin is or is not secondary is merely a relative statement. Anybody today can see instances of reconcentration taking place in the present river beds. Nor do I suppose that Dr. Falconer claims that the drift is of very great antiquity. Still, looking at those places where one can see the present river channels actually cutting their way down through the tin-bearing drift, it seems impossible to deny the secondary origin of a great deal of the alluvial tin in Nigeria.

As regards the origin and formation of the drift, the so-called laterite, the flat-topped hills of the plateau and the relation of the drift to the lava flows, these seem to offer a wide field for geological research. When Dr. Falconer originally visited Nigeria there were not the same opportunities for studying the drift and its old channels as there are now, but I hear that he has returned to Nigeria in the political service, and possibly he may be able to revisit the tinfields and to see enough of the more recent workings to enable him to give us the benefit of some further explanations of these drift deposits.

WILLIAM R. RUMBOLD.

London, June 28.

SPECIAL CORRESPONDENCE

CAMBORNE.

In the June issue of the Magazine reference was made to Sir William Beardmore's statement regarding the excellent results from the employment of women on munition work. The accompanying photograph was taken in the rock-drill department of Holman Brothers' works at Camborne, where there are 370 girls employed, on three shifts. Special accommodation is provided under the supervision of matrons. The introduction of women has enabled the firm to maintain its output. Here, as in other plants where new labour has been brought in, special inspection is necessary, but an elaborate inspection department was installed a few years ago.

MINES RECRUITING COURT.—At last the government authorities have realized the need of a special court to deal with the cases of mine employees of military age who come within the Military Service Acts of 1916. Until recently, all applications for exemption have been dealt with by the ordinary tribunals, who often know nothing of the special requirements and conditions of the mines, and in some cases have appeared to care less. In particular, some of the mines outside the Camborne-Redruth area appear to have been badly crippled by the loss of miners, and this has been largely because the tribunals have consisted of farmers and others who had no knowledge whatever of the labour difficulties at the mines, nor appeared to understand that the heavy standing charges of a mine are such as to make profitable working impossible unless a reasonable output can be maintained. Individual mines have, to the writer's knowledge, represented the facts to the government departments concerned, but it needs combined action to get speedy attention on the part of the

ROCK-DRILL DEPARTMENT AT HOLMAN'S WORKS, RUN BY FEMALE LABOUR.

authorities. This is where the Chamber of Mines will be of value in the future. The new court consists of a representative each of the Home Office (the local Inspector of Mines), the mining companies (Josiah Paull of South Crofty), and the employees.

CORNISH CHAMBER OF MINES.—On June 14, a representative meeting of Cornish mine interests was held at the Camborne Mining School to consider the question of the formation of a Mining Board for Cornwall, as was outlined in a leading article in the April issue of the Magazine. Mr. R. Arthur Thomas of Dolcoath presided, and the chief advocates of the advantages of combination were Messrs. C. A. Moreing (East Pool), Oliver Wethered (Geevor), J. M. Holman, and C. V. Thomas. Nearly every mine in the county of any consequence was represented and there was no dissentient voice; so it is to be hoped that the new organization (which the meeting preferred to call a Chamber of Mines) will command the active and sympathetic support of all the mines, large and small. As Mr. Wethered truly said, it would be better to "see this promising infant throttled at its birth than that it should be allowed to die of inanition afterward from want of enthusiasm." In particular, the smaller mines would do well to support the Chamber, because, whereas a large concern can often by its influence and monetary resources successfully deal with most of its own difficulties, the smaller company is more often able only as a unit of a combination to secure desirable concessions.

GEEVOR.—The belated report and accounts of this company for the year ended September 30, 1915, show that a gross profit of £4358 was earned, from which has to be deducted £2549 for interest, £1056 for depreciation, and £200 written-off preliminary expenses, showing a net profit of £553. It is evident, from the records of the past two or three years, that this property is well worthy of vigorous development, but the company lacks capital, and as a consequence the development programme has had to be curtailed. The development for the period under review figures at one ton for every 13 tons milled, which is quite an inadequate ratio for a mine with such narnow lodes as Geevor. The tonnage handled was 25,487, or much the same quantity as in the previous year, and the yield was 353 tons of black tin, or 31·9 lb. per ton. The average working cost was 20s. 10d. per ton, which is quite a reasonable figure bearing in mind the narrow lodes and the distance of the mine from the rail-head. From a circular issued subsequent to the meeting, in which the assay-values of eight working faces are given, it would appear that the average width of the lode proper is 1 ft., and the average assay-value 163 lb. black tin per ton. The stopes are carried from 3 to 4 ft., and part of the rock mined contains tin of sufficient value for profitable treatment.

EAST POOL & AGAR.—The maiden dividend of 1s. per share was paid on June 30, and it is likely to be followed by another at the end of the year. Although hardly any stoping is being done on the new (Rogers) lode, the sales continue to rise, and it is interesting to compare the last sale of 36 tons of tin concentrate on July 3 (being two weeks' return) with the 23 tons sold a year ago on July 5.

TORONTO.

PORCUPINE.—The Hollinger is pushing the construction of the addition to the mill, which will increase its capacity by 2000 tons per day, as rapidly as possible, and has let contracts for the foundation work. It will be the largest single construction work ever undertaken by any Canadian mine, and will cost $750,000. The statement for the four weeks ended May 19 shows gross profits of $154,369 from the treatment of 33,558 tons of ore of the average value of $8 per ton, at a working cost of $3·33 per ton milled. In addition the mill treated 13,003 tons from the Acme property, the value of which is not stated. The Dome Mines made a new high record for the month of May with a production of $189,600 as against $177,000 in April, from the milling of 39,400 tons of ore of the average grade of $4·80 per ton. It has been definitely decided to substitute ball-mills for stamps for ore-crushing, and three more ball-mills will shortly be installed. The agreement giving the company the right to buy out the Dome Extension was ratified by the shareholders at the annual meeting on May 30. The West Dome has considerably improved its position, the vein which is 4 ft. wide at a depth of 270 ft. in the shaft giving high assays. A station is being cut at 200 ft. Diamond drilling has proved the persistence of the orebodies to a depth of 900 ft. The Schumacher has done 300 ft. of driving on the 600 ft. level, where a vein 6 ft. wide carries good milling ore. Frank L. Culver, president of the Beaver and Timiskaming companies of Cobalt, has become interested in this property and has been chosen as one of the directors. At the McIntyre the vein discovered on the 700 ft. level is developing well, and a rich find on the 1000 ft. level is officially announced.

A consolidation of the McIntyre group of properties, including the McIntyre, McIntyre Extension, and Jupiter, now working in conjunction, is contemplated, and it has been decided to obtain a report by an independent engineer to arrive at a basis of valuation. Another proposed consolidation is the amalgamation of the Vipond and the North Thompson, which are being sampled for that purpose. The Vipond has completed a rise from the 400 ft. to the 300 ft. level, which will render accessible the high-grade ore on the lower level. The Nipissing Mines Co., of Cobalt, will take over the Plenaurum, situated to the northeast of the McIntyre group, in which Messrs. Earle and Watson of the Nipissing are heavily interested. The Plenaurum covers 120 acres, upon which little development has hitherto been done.

KIRKLAND LAKE. — Electric power will shortly be available at Kirkland Lake. Work has been started on the 65 mile transmission line of the Northern Ontario Light & Power Co. from Cobalt to Kirkland Lake, and will be pushed as rapidly as possible. At the La Belle Kirkland the shaft is down 330 ft. on a 6 in. high-grade vein which has persisted all the way down. A station has been cut at 270 ft. The Tough Oakes Co. has laid out a townsite and is leasing building lots to the employees and others. A rich find has been made on the No. 6 vein at the 250 ft. level. At the Lake Shore good ore is being taken out of the vein 400 ft. from the shaft, and two shoots of high-grade have been found. At the McKane claim, operated by the Beaver of Cobalt, the shaft is down 200 ft. The drift on the 100 ft. level is in ore for 115 ft., the assays showing high gold content.

COBALT.—The silver-mining industry continues very active with heavy shipments. Many mines and prospects which have been closed for some time are being re-opened. The Nipissing during May produced bullion to the amount of $291,898. At the McKinley-Darragh the oil flotation plant is in operation, treating the tailing. The Trethewey is again being worked, the mill treating ore formerly left in the mine because it was of too low a grade to render its extraction profitable. The company is operating the Rochester under lease and driving on a vein on the 200 ft. level. The Adanac has installed a new hoist and is taking good ore from a 10 in. vein at the 300 ft. level. The Beaver shaft is down 1630 ft., and has arrived at the contact between the Keewatin and diabase. A station is being cut at the 1600 ft. level from which cross-cutting will be undertaken. A high-grade ore-shoot 4 in. wide has been found on the 530 ft. level. The annual report of the Peterson Lake for the year ended April 30 shows a total income of $303,183, practically all derived from royalties paid by the Seneca Superior. At the annual meeting held on June 17, a keen contest for the control of the company resulted in the re-election of the old directorate. The Timiskaming & Hudson Bay, which lately resumed operations, is bagging high-grade ore running 4000 oz. to the ton from the breaking down of the pillar along the Nipissing boundary. An agreement has been effected between the Ophir and People's Mines under which these companies will jointly develop their respective properties down to the Keewatin and diabase contact at a depth of 600 ft. The Kerr Lake has taken a sampling option on the Maidens property in South Lorrain. The Mining Corporation of Canada is making extensive alterations to the mill, replacing much of the old machinery with units of more modern types.

RICE LAKE.—Valuable gold deposits have been discovered in the Rice Lake district, Manitoba, lying between Lake Winnipeg and the Ontario boundary and about 100 miles northeast of Winnipeg. The showing of rich samples brought to Winnipeg by miners had created much interest among capitalists, and several companies are being formed to exploit the district. Many prospectors from Winnipeg and the mining districts of Ontario have gone to the new camp. The principal drawback to its success is the lack of transportation facilities, as it is 50 miles from the nearest railroad and there are numerous portages on the water route. The Provisional Government has commissioned Prof. R. C. Wallace, provincial mineralogist, to make an examination of the district.

EASTERN SIBERIA.

THE PRIMORSK district consists of the lower reaches of the Amur river, its tributaries, the Amgun, Udil, etc., the land between the Amur and the Ochotsk Sea, and the Siberian coast from the Arctic to the Korean border. Most of this vast district has not yet been prospected, and there is plenty of scope for foreign capital in these parts. The majority of the mines in the district are at present being worked by primitive methods, and are in the hands of people with no capital, whose main idea is not to produce gold but to make money on trading. It is an easy matter to open a small claim, and secure the services of a hundred or more Chinamen to work on rental or percentage basis.

while the owner starts a store and makes his money on the goods he sells to the Chinamen. The output of this district for 1915, as given to the Gold Mining Association for taxing purposes, is as follows:

	Poods	Funts	Zolotniks	Dolis
Ochotsk Co. (Orsk)	53	09	13	23
Amur Co	22	16	65	54
1st Udil Co	15	22	88	—
Eltsoff & Levashoff	14	16	90	60
H. I. Henricksen	9	13	95	09
Amgun Co	8	01	83	06
Akkerman A. A.	4	13	66	66
Amur-Orel Co	2	34	89	59
Zabirova	1	23	23	91
Haimovitch	1	06	32	32
Belopuhoff M. A.	—	39	08	84
Masukoff A. S.	—	30	54	60
Mironoff I. F.	—	28	79	79
Bobroff S. S.	—	21	15	59
And 11 small firms under half a pood each	2	—	08	74
Total	137	39	47	84

This total equals about 72,600 ounces, and the gold averages 850 fine. Of the above, the Ochotsk are mines rented to the Orsk Goldfields, Ltd., and is therefore a purely British concern. This company own two dredges, one electrical and one steam, besides employing a number of Chinamen on tributer work. The Amgun Company operates two dredges of makeshift construction, and although the output is insignificant, the average recovery during nearly 10 years operation gives promise that with larger dredges the field would be a promising one. Of the other mines showing a fair output, the Amur Company works by primitive methods with horses and carts. Eltsoff & Levashoff, Henricksen, and the 1st Udil Co. are all purely tributing mines, though the last named has just bought a dredge abandoned by the Marquis of Winchester Company at the mouth of the Udil river. All the rest are worked by the most primitive methods, and in most cases are owned by people who have no capital of any kind, and struggle along, paying the banks huge interest for accommodation. Besides the companies above mentioned, there are a number of new concerns on the north shore of the Ochotsk sea. These claims are said to be rich, but as they are situated far to the north, only a firm controlling big capital can work them. Besides the Vogelman property there are numerous properties awaiting development, and hundreds of versts are not yet prospected. In the non-prospected area there is a lake which has been proved to have gold in it, and into this lake seven streams run, none of which have been prospected because all the land is very boggy and only fit for dredging work, while there are no Russian firms in the district which have capital to buy dredges. Besides placers there are several quartz properties.

NEW YORK.

Between fears on the part of the general public that the United States will soon be regularly at war with Mexico, and fears by munition makers that it won't, there has been a market reaction, though not a serious one. Money is still coming forward easily, the railroads have raised their freight embargoes, and ocean rates, though still high, have fallen. Your Admiralty seems to have got its grip on things and by better organization is accomplishing its work with fewer merchant ships. New tonnage from the American yards, too, is coming forward or is so near delivery as to begin to affect rates, so that if the threatened railroad strike be avoided industry here should do well for the remainder of the year. In the metal trade zinc still holds the centre of the stage despite a drop in price duly recorded by quotations of the last weeks. Prices are yet far above normal and producers are not unhappy. Most of the smelting companies have wisely taken advantage of the period of high prices to improve or amortise their plants and they will be in excellent condition to withstand a period of prices even below normal if such should follow the war. The mines will not be in such good condition; sheet-ground miners at Joplin, for example, when blende sells at $40 per ton (it is now $75 to $80) have only a gross return of about $1 or 4s. 2d. out of which to pay royalty, expenses, and profit. For most of them this just about determines the limit of workability. In the west where complex ores must be treated, conditions are more hopeful since the war period is forcing technical development, and ores can now be handled that previously had no value. The combination of flotation and electrolytic work undertaken by the Anaconda company has already received notice, but there are many other processes being applied. The River Smelting & Refining Co., of St. Louis, is using a combination of matte smelting with sublimation of the lead and zinc, followed by electrolytic separation of the metals, and anticipates making a profit out of low-grade Colorado ores with lead, zinc, and silver at normal prices. The electrolytic work is done at Keokuk, Iona, with power developed by a subsidiary of the Consolidated Gold Fields of South Africa. This is only one of many developments brought about under the stimulus of high prices.

PERSONAL.

P. M. ANDERSON has been appointed manager of the Geduld mine in the Far East Rand.

H. FOSTER BAIN arrived in London July 1, on the conclusion of his visit to South Africa and Congo Belge.

A. DE BAUW, Director of the Department of Industry and Commerce in Katanga, is in London.

ERNEST R. BAWDEN has been appointed manager of the Threlkeld lead mines, Cumberland.

CHARLES P. C. BERESFORD has returned to West Africa to resume his duties as acting general manager of the Prestea Block A mine.

E. J. S. BOLTON has arrived from the Rand to take up war work.

WILLIAM BRADEN is paying a visit of some length in Peru.

WALTER BROADBRIDGE is home from the front on sick leave.

WALTER LYMAN BROWN is in charge of the Rotterdam office of the Commission for Relief in Belgium.

W. A. CARLYLE has left for Canada and will make his headquarters in Toronto.

GEORGE CHALMERS, manager for the St. John del Rey Mining Co., is in London.

G. A. DENNY is temporarily acting as adviser to the Albu group for their mines in the western part of the Rand, during the absence of Robert Pill.

JAMES THOMSON DIXON has joined the firm of Inder & Henderson, which in future will be known as Inder, Henderson, & Dixon.

S. H. FORD, manager of the Abbontiakoon, West Africa, has left London on his return to the mine.

H. G. B. FRYERS has returned to England from Johannesburg, where he was on the staff of the Crown Mines.

F. LYNWOOD GARRISON has left New York on a lengthy visit to Brazil.

THOMAS GRAHAM, Chief Inspector of Mines for British Columbia, has been visiting the Joplin district, Missouri.

U. S. GRANT has been visiting California and the Pacific Coast.

R. E. GRIGGS is in London on his way to New York on a mission from the Transvaal Chamber of Mines relative to securing prompt shipment of supplies needed for the Rand mines.

F. H. HAMILTON is back from Porcupine.

E. MACKAY HERIOT has been appointed manager of the San Miguel copper mines, in the south of Spain.

FRED HELLMANN left New York on his return to Chuquicamata, Chile, on June 10.

D. F. HIGGINS is in London from Korea.

A. B. W. HODGES has returned from Honolulu to Los Angeles, California.

W. C. HOLDEN is here from Peru and is staying at Sandgate, Kent.

W. D. HOLE has returned to England after three years service as manager of the Poderosa mines, Chile.

HENRY MARION HOWE has been elected an honorary vice-president of the Iron and Steel Institute.

J. M. ILES is on his way home from Nigeria.

CHARLES JANIN is examining an alluvial gold property near Fairbanks, Alaska.

ALFRED JAMES has moved his office from 2 Broad Street Place, E.C., to 28 Victoria Street, Westminster.

A. E. KITSON, Government Geologist for the Gold Coast, lectured last month before the Royal Geographical Society on the resources and conditions of that colony.

E. FLEMING L'ENGLE has accepted the position of manager for the Royal Zinc Co., Joplin, Missouri.

R. R. LESLIE, manager for the Butters Divisadero Co., Salvador, is in London.

V. F. STANLEY LOW has arrived from South Africa, after a short visit on his way from Australia.

H. T. MARKS has gone to South Africa and will visit the Travsvaal and Rhodesia.

L. MARKS has come from Johannesburg to enter war work.

J. J. MARTIN has returned to Korea to resume the management of the mines of the Chiksan Mining Co.

L. J. MAYREIS has joined the staff of the Burma Corporation, and left London on June 22.

RALPH H. MCKEE has become head of the research department of the Tennessee Copper Company.

E. T. MELLOR has resigned from the Geological Survey of South Africa, and has been appointed consulting geologist to the Central Mining & Investment Corporation.

FRANK MERRICKS has been elected president of the Mining and Metallurgical Club and BEDFORD MCNEILL vice-president.

WILLET G. MILLER sailed on May 23 from San Francisco for Australia and New Caledonia.

H. A. MITCHELL has joined the staff of the Broken Hill Proprietary, and his duty will be in connection with the legal control of wages.

F. M. MURDOCH, lately at the Pernatty copper mines, South Australia, has gone to the Hampden mine, Cloncurry, Queensland.

ELDER NANCE is on the Western Front with the Tunnelling Corps of the Royal Engineers.

J. SCOTT PARK has left for Naraguta, Nigeria, to take the managership of the Champion Tin Fields.

C. P. PERIN has been in London on his way to India.

F. DANVERS POWER has changed his address to Perpetual Trustee Chambers, Hunter Street, Sydney.

WILFRED RICKARD has been appointed manager of the Empress mine at Mount Magnet, Western Australia.

HUGH ROSE, manager of the Santa Gertrudis, Mexico, is visiting in Massachusetts.

RENO H. SALES has returned to the United States after a visit to South America.

JAMES SCOTT is expecting to return to England in September from Jemaa, Nigeria.

H. ROSS SKINNER has left London for Johannesburg, where he will take up the position of resident director of the Central Mining & Investment Corporation.

J. E. SPURR is inspecting the Pas gold-mining district of Manitoba.

WALLACE THORNYCROFT has been nominated as president of the Institution of Mining Engineers for the next year.

R. C. N. TWITE has gone to Tavoy, Burma.

O. B. WARD, manager for the Broken Hill Block 10 company, has returned to Australia from Papua, where the company is operating a gold property.

S. J. WEIS has resigned his position with Fraser & Chalmers to join the staff of the Lenskoie company, in Russia.

T. W. WELLSTED, a member of the firm of Bewick, Moreing & Co., has returned from Australia.

MORLEY J. WILLIAMS is returning from India.

A. W. WINCEY has been appointed mill superintendent for the Broken Hill Block 10 company.

L. A. WOMBLE has resigned as manager of the Geduld mine in the Far East Rand.

GEORGE J. YOUNG, professor of mining engineering in the University of Minnesota, has been appointed professor of metallurgy at the Colorado School of Mines.

METAL MARKETS

COPPER.—The decline in values has been precipitate during the past month. At no time has the market appeared to be under any pressure, the turnover indeed even under the present conditions being moderate, yet with occasional rallies. Copper has dropped in price between one session and another by as much as £4 to £5. From £126 for cash early in June, the price fell as low as £98, and three months from £119 to £96. The month of June closed with a fairly substantial rally, but prevailing conditions do not point to its lasting. In refined sorts, consumers have shown no activity, which on a falling market is not surprising. Second hands have accordingly had things pretty much their own way, and while taking whatever orders are going, they have put pressure on the market with an eye to purchasing cheaper later on. The electrolytic quotation has fallen from 27½–29c., New York to 26–26½c., and in this country from £142–£138 to £134–£130. Producers appear somewhat shaken in their resolve to maintain prices, at least as regards forward deliveries. For prompt metal they are much more independent. In America the feverish demand has subsided, and with the greatly improved shipping facilities holders are seeking an outlet here on more favourable conditions. Large quantities of scrap are finding their way to market, and competing with new material.

The following were the quotations on July 7 for copper and brass: Tough Copper £123 per ton, best selected £125, American electrolytic wire-bars £131. 10s., cathodes £131. 5s., solid drawn tubes 18½d. per lb., brazed tubes 18½d., wire 19d., yellow metal 16d., Brass solid drawn tubes 15¾d. per lb., brazed tubes 17¾d., rods 16⅝d., sheets 16⅝d., wire 16½d.

Average prices of cash standard copper: June 1916, £112. 17s. 9d.; May 1916, £135. 9s. 11d.; June 1915, £82. 13s. 8d.

TIN.—Trading has been dull and price movements show no decided tendency. On the whole values are lower, but the level is moderate as measured by the experience of recent years, and contrary to what has happened in other metals is lower than that of pre-war days. The price has fluctuated between £185 and £170, the month of June closing at £174 cash and £174. 15s. three months. Business with home consumers is quiet, and that with America disappointing. A buying movement from America is overdue. Buyers have held off for two months. France and Russia have both been buying freely, and some large contracts have been fixed for shipment to the Far East. The restrictions put upon exports is hampering the trade in English tin. Licences are being granted very sparingly, with the effect of bringing the Dutch brands into prominence. Java sales are being held back for higher prices. The scarcity of freight opportunities makes it difficult for shippers to take advantage of quick market movements. American deliveries for June again exceed 5000 tons.

Average prices of cash standard tin: June 1916, £179. 11s. 3d.; May 1916, £196. 11s. 9d.; June 1915, £167. 17s. 3d.

SPELTER.—Prices are wild but quotations are distinctly downward. Distrust in the present level is general both in America where producers have become keener to sell, and here where consumers have become reluctant to buy. Dealing is mostly from hand to mouth with enormous premiums for spot delivery. The official quotation at the end of June was £61–£53 as compared with £70–£60 at the beginning of June. The present price is still lower, at £44–£40. Facilities for shipment are now better.

Average prices of good ordinary brands: June 1916, £63. 16s. 4d.; May 1916, £89. 11s. 4d.; June 1915, £100. 12s. 3d.

LEAD.—Little business is passing. Metal for munitions is being imported by the authorities, and general trade is dead. The price has come down steadily during the whole month with occasional periods of acute depression, and now stands at £28. 15s. cash and £28 forward, as compared with £32 cash and £31. 7s. 6d. at the beginning of June. Odd lots of spot lead have been fetching heavy premiums, but the amount of trade done is inconsiderable, and no interest is shown in forward business. The American quotation has been reduced to 6·50c. per lb. This is still well above London parity. Freight conditions are easier.

Average prices of good soft pig lead: June 1916, £30. 14s.; May 1916, £32. 19s. 5d.; June 1915, £25. 4s. 1d.

ANTIMONY.—As is the case with other war metals, antimony has experienced a weakness in price during the last month, and sales have been effected at lower rates than the Government price. For some time, users outside the munition works have paid as much as £120 per ton, as compared with the official price of £95. In America there has been a considerable slump in the metal, and it is now being sold at 18c. per lb., about £85 per ton. Antimony crude is quoted at £42 per ton, as compared with £65 a month ago. Arrangements for increasing the deliveries of antimony ore from South America have been upset by the fall in price and the difficulty of finding freight accommodation.

QUICKSILVER.—An upward turn in the price for Spanish quicksilver is recorded, and the quotation is now £17. 15s. per flask of 75 lb. In America a few months ago, the price was fabulously high, but last month we reported a fall to $90 per flask. Since then the price fell to $65 per flask. During the last week or so, the market has become firmer, and the price has risen slightly. The export of quicksilver from Mexico is now forbidden, a fact which may explain this check to the fall in American prices.

ALUMINIUM.—This metal is still controlled by the Government. About £150 per ton is the price paid by outsiders. In America the demand is greater than the supply, and the controlling company is advancing the price steadily. The latest quotation is 65c. per lb., equal to about £300 per ton.

BISMUTH.—The Government controls this metal, and Johnson, Matthey & Co. are not giving any public quotation. For a long time their price was 10s. per lb., but probably 12s. to 15s. is being paid now. The price of 11s. is also quoted elsewhere. In the United States the price is 13s. to 13s. 6d.

CADMIUM.—8s. per lb.

PLATINUM.—This metal continues under Government control, and Johnson, Matthey & Co. act as official purchasers at 190s. per oz. In America the market is quiet, and the quotation is about $78 per oz., a slight fall as compared with $80 a month ago.

NICKEL.—The price continues at £225 per ton, and in America at 45 to 50c. per lb. The Mond Nickel Co. announces an intended expansion of output.

IRON.—We recorded last month that the official maximum prices for No. 3 Middlesbrough iron had been raised from 82s. 6d. to 87s. 6d. per ton, and we mentioned that makers of other brands had expected a similar concession on the part of the Government. No action of this sort has yet been taken, and it is doubtful whether any advance will be granted. The rate of output of hematite iron is being greatly expanded, and it was in this market where the greatest pressure of buying was exhibited. The stocks of pig iron continue to diminish, and hardly any is allowed to leave the country except for the service of the Allies. The control prices are as follows: West Coast hematite 127s. 6d. per ton, East Coast hematite 122s. 6d., South Staffordshire cold blast 177s. 6d., Scottish foundry and forge 114s. Spanish iron ore is quoted at 39s. 6d., and Swedish ore at 41s. delivered on the northeast coast. Of manufactured products, Middlesbrough steel plates for ships are quoted at £11. 10s. per ton for home delivery and £14. 15s. for export, steel rails £10. 17s. 6d., galvanized sheets £29.

MANGANESE.—Indian manganese ore on 50% basis for delivery this year is quoted at 2s. 6d. per unit c.i.f. England, and Brazilian ore on the same terms at 4s. Ferro-manganese remains at £25 for home orders and £30 to £40 for export, but little is available for export at present. The ferro-manganese position in America is easing considerably, and the price for early delivery has fallen from £80 to £45. It is reported that additional supplies of manganese ore are being obtained by American firms from Cuba. The United States Manganese Corporation has been incorporated for the purpose of mining manganese ore at Elkton, Virginia; it will sell ore on the market, and also produce ferro-manganese. Metallic manganese is quoted in Sheffield at 4s. per lb. 90–95% pure free from carbon.

MOLYBDENUM.—This metal is still under government control and the price of molybdenite 90% MoS_2 continues at 105s. per unit. At Sheffield ferro-molybdenum is quoted at 16s. per lb. 65 to 80% Mo.

TUNGSTEN.—This metal continues under government control and the price for wolfram and scheelite ores is on the basis of 70% WO_3 at 55s. per unit. The output of ore in Burma is being increased, the Government aiding operations by providing labour from other parts. The search for tungsten ores in America has brought so many offers of supplies that the market is slightly congested, and prices though still high are uncertain. Some transactions are reported at $30 to $40 per unit. It is stated that orders for ore have been placed in America for France and Russia, but no notable shipments have been made so far. In England high-speed tool steel is sold at 2s. 10d. per lb. for 14% tungsten, and 3s. 10d. for 18% tungsten. Old bar ends are re-purchased at 6d. and turnings at 5d. Ferro-tungsten is quoted in Sheffield at 6s. 1d. per lb. 80–90% low carbon; tungsten metal powder 96–98% 6s. 3d. per lb.

TITANIUM.—Ferro-titanium 15–18% Ti, 5–8% carbon, 6½d. per lb.; 23–25% Ti carbonless, 1s. 5d. per lb.

VANADIUM.—Ferro-vanadium, 15s. per lb. of vanadium contained.

COBALT.—96–98% metal 7s. 6d. per lb.

CHROMIUM.—Chalas & Sons give the following quotations for chrome ores: New Caledonia 53–55%, f.o.b., basis price for 50% Cr_2O_3 36s. per ton, scale 2s.; Baluchistan ore 53–55%, basic price for 50% Cr_2O_3 60s. per ton, scale 2s.; no quotation for Rhodesian ores. At Sheffield the quotations for ferro-chrome are: 4–6% carbon £38 per ton basis 60%, scale 12s. 6d. per unit; 6–8% carbon £36 per ton basis 60%, scale 10s. per unit; 8–10% carbon £34 per ton basis 60%, scale 10s. per unit; maximum 2% carbon £120 per ton basis 60%, scale 32s. 6d. per unit; metallic chromium 92–99% 5s. 9d. per lb.

SILVER.—The silver market, after the boom of a month or so ago, settled down to more ordinary conditions, the price varying between 30d. and 31d. per standard ounce. During the last week another fall brought the price below 29d.

PRICES OF CHEMICALS. July 10.

		£	s.	d.
Acetic Acid, 40%	per cwt.	3	12	6
,, 60%	,,	5	5	0
,, Glacial	,,	10	0	0
Alum	per ton	12	0	0
Alumina, Sulphate of	,,	15	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	13	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	16	0	0
Arsenic, White	,,	33	0	0
Barium Chloride	,,	31	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	18	0	0
Borax	,,	34	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	55	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	0	0
Lead, Acetate of, white	,,	105	0	0
,, Chemical Sheet Metal	,,	39	0	0
,, Nitrate of	,,	75	0	0
,, Oxide of, Litharge	,,	45	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	9
Phosphoric Acid	,,			11
Potassium Bichromate	,,		1	10
,, Carbonate	per ton	150	0	0
,, Chlorate	per lb.		2	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		9	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	6
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	80	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	16	0	0
,, Nitrate, 95%	,,	18	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	26	0	0
Sulphur, Roll	,,	13	0	0
,, Flowers	,,	13	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	6
Tin Chloride (Tin Crystals)	,,		1	4
Zinc Chloride, solution 100°T.	per ton	32	0	0
Zinc Sulphate	,,	29	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
July 1915	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8 772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773

Cost and Profit on the Rand

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	—	135,289	—
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	[illegible]	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	1,630,892	1,706,473	698,257

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1913	86,255	1,227,888	1,314,143	5,582,140
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
Total, 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	—	18,000
July	154,800	—	88,830	—	—
August	80,300	—	93,050	—	—
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	535,500	1,078,560	422,200	206,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	—
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	1,140,170

Daily London Metal Prices
in £ per long ton.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard
June	£ s. d.	£	£ s. d	£	£ s. d.
1	121 5 0	142	31 15 0	75	187 10 0
2	121 5 0	142	32 0 0	70	186 0 0
5	123 10 0	142	31 17 6	73	183 10 0
6	124 0 0	144	32 0 0	76	183 0 0
7	123 10 0	144	32 5 0	73	184 10 0
8	123 10 0	144	32 7 6	73	187 10 0
9	123 10 0	144	31 15 0	71	187 15 0
12	121 0 0	144	32 0 0	71	184 10 0
13	121 0 0	142	31 5 0	68	181 10 0
14	119 0 0	142	31 10 0	68	183 5 0
15	119 0 0	142	31 10 0	68	181 5 0
16	113 0 0	142	31 5 0	68	178 0 0
19	109 0 0	140	31 7 6	68	178 0 0
20	106 0 0	139	31 7 6	68	176 15 0
21	99 0 0	138	31 0 0	67	173 2 6
22	97 0 0	136	30 0 0	67	172 5 0
23	98 0 0	132	29 10 0	66	175 15 0
26	102 0 0	132	29 10 0	65	173 5 0
27	102 0 0	132	29 10 0	65	171 10 0
28	102 10 0	132	29 0 0	63	172 0 0
29	103 10 0	134	29 5 0	63	173 10 0
30	103 0 0	134	28 15 0	61	173 15 0
July					
3	101 15 0	134	28 0 0	51	172 5 0
4	98 10 0	133	28 0 0	48	170 5 0
5	96 10 0	133	28 0 0	46	172 5 0
6	96 10 0	132	28 0 0	46	173 5 0
7	90 0 0	130	27 17 6	44	173 5 0
10	84 0 0	130	28 0 0	44	170 0 0

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	May 1916	June 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	3,284	1,474	17,386
,, Matte and Precipitate	38,372	1,461	4,787	22,514
,, Metal (unwrought and part wrought)	180,368	8,760	11,551	59,801
Copper and Iron Pyrite	903,401	93,555	60,388	514,125
Tin Concentrate	44,748	2,268	2,225	15,902
,, Metal	38,896	4,268	2,590	17,762
Manganese Ore	377,324	42,068	50,826	225,492
Lead, Pig and Sheet	256,476	13,785	11,550	87,928
Zinc (spelter)	74,520	2,838	4,561	19,797
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	—	—	

Stocks of Copper.
Reported by Henry R Merton & Co. Ld. Long tons.

	April 30, 1916	May 31, 1916	June 30, 1916
	Tons	Tons	Tons
Standard Copper in England	1,052	1,957	2,148
Fine Copper in England	1,601	935	2,070
,, ,, Havre	4,570	3,770	3,385
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	3,700	3,000	2,225
,, ,, ,, from Australia	5,000	4,100	4,000
Total Visible Supply	21,046	18,785	18,951
In other European Ports Estimated	—	—	—

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1915	Long tons	1916	Long tons
January	28,197	July	16,812	January	21,863
February	12,066	August	16,289	February	20,548
March	29,725	September	14,327	March	24,006
April	20,481	October	26,153	April	19,980
May	25,785	November	19,396	May	14,700
June	15,751	December	32,936	June	38,277
		Total 1915	257,915	Total 1916	139,374

Stocks of Tin.
Reported by A. Strauss & Co Long tons.

	April 30, 1916	May 31, 1916	June 30, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,804	1,862	1,537
Ditto, Landing and in Transit	1,054	650	225
Other Standard, Spot and Landing	1,005	1,862	1,399
Straits, Afloat	3,858	2,960	5,125
Australian, Afloat	384	500	500
Banca, on Warrants	—	—	—
Ditto, Afloat	4,762	4,375	3,640
Billiton, Spot	7	—	—
Ditto, Afloat	217	123	400
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,555*	1,010*	1,450*
Afloat for United States	3,885	5,190	3,325
Stock in America	2,756	2,468	3,963
Total Stock	21,287	21,000	21,564

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin
Reported by A. Strauss & Co. Long tons.

	Year 1915	May 1916	June 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	1,415	3,665	14,285
Straits to America	31,565	2,145	1,700	13,900
Straits to Continent	11,024	405	845	4,190
Australia to U.K.	2,481	312	228	1,670
U.K., Holland, and Continent to America	14,967	1,928	1,515	7,293
Imports of China Tin into U.K. and America	3,012	1,080	240	1,565
Imports of Bolivian Tin into Europe	22,591	982	770	6,571

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	—
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	2,628

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters. Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	—
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	21,725

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
September 13, 1915	149	£12,554	£84 5 1
September 27	171½	£14,459	£84 6 3
October 11	166	£13,620	£82 1 0
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	July 1 1915	June 5 1916	July 5 1916
RAND:			
Bantjes	9	14	14
Brakpan	54	82	85
Central Mining (£12)	130	127	129
Cinderella	3	6	6
City & Suburban (£4)	47	37	39
City Deep	60	80	80
Consolidated Gold Fields	24	27	32
Consolidated Langlaagte	37	35	35
Consolidated Main Reef	19	19	20
Consolidated Mines Selection (10s.)	9	17	16
Crown Mines (10s.)	82	61	61
Daggafontein	6	15	15
D. Roodepoort Deep	17	15	15
East Rand Proprietary	26	14	15
Ferreira Deep	44	30	27
Geduld	28	45	45
Geldenhuis Deep	21	24	26
Gov't Gold Mining Areas	21	37	37
Heriot	64	52	50
Jupiter	6	6	8
Kleinfontein	23	27	29
Knight Central	6	12	12
Knight's Deep	29	29	29
Langlaagte Estate	19	19	19
Luipaard's Vlei	7	9	9
Main Reef West	7	7	7
Meyer & Charlton	109	111	111
Modderfontein B	101	137	136
Modder Deep	84	135	134
Modderfontein, New (£4)	290	340	341
Nourse	22	15	14
Rand Mines (5s.)	92	70	73
Randfontein Central	11	11	11
Robinson (£5)	35	20	20
Robinson Deep	25	20	19
Rose Deep	37	24	25
Simmer & Jack	11	7	7
Simmer Deep	1	2	2
Springs	21	54	55
Van Ryn	61	45	44
Van Ryn Deep	51	70	70
Village Deep	36	32	31
Village Main Reef	30	17	17
Witwatersrand (Knight's)	65	60	59
Witwatersrand Deep	33	25	25
Wolhuter	11	11	10
OTHER TRANSVAAL GOLD MINES:			
Glynn's Lydenburg	207	220	230
Sheba (5s.)	10	17	15
Transvaal Gold Mining Estates	52	67	67
DIAMONDS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	95	102	105
Jagersfontein	4	2	2
Premier Diamond Defer'd (2s. 6d.)	36	23	26
RHODESIA:			
Cam & Motor	14	13	14
Chartered	9	12	14
Eileen Alannah	6	10	9
Eldorado	14	11	11
Enterprise	5	5	6
Falcon	8	13	16
Giant	7	7	7
Globe & Phœnix (5s.)	27	24	26
Lonely Reef	23	24	24
Shamva	37	35	36
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	5	5	5
WEST AFRICA:			
Abbontiakoon (10s.)	8	7	8
Abosso	7	10	10
Ashanti (4s.)	15	18	18
Broomassie (10s.)	1	½	½
Prestea Block A	11	9	10
Taquah	15	18	19
WEST AUSTRALIA:			
Associated Gold Mines	5	5	4
Associated Northern Blocks	4	4	4
Bullfinch	6	5	5
Golden Horse-Shoe (£5)	47	37	35
Great Boulder Proprietary (2s.)	14	14	13
Great Boulder Perseverance	1	1	1
Great Fingall	3	2	2
Ivanhoe (£5)	47	44	44
Kalgurli	34	12	12
Sons of Gwalia	16	16	16
Yuanmi	2	2	3

GOLD, SILVER, *cont.*	July 1 1915	June 5 1916	July 5 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	11	11	6
Mount Boppy	10	11	10
Mount Morgan	49	42	40
Progress	7	5	4
Talisman	21	12	12
Waihi	39	37	37
Waihi Grand Junction	23	19	19
AMERICA:			
Alaska Treadwell (£5)	147	127	117
Buena Tierra	13	12	12
Camp Bird	5	10	9
Canadian Mining	8	12	12
Casey Cobalt	7	7	7
El Oro	7	10	9
Esperanza	8	11	11
Frontino & Bolivia	9	11	11
Le Roi No. 2 (£5)	12	11	10
Mexico Mines of El Oro	67	82	80
Oroville Dredging	14	16	17
Plymouth Consolidated	18	23	27
St. John del Rey	15	15	16
Santa Gertrudis	7	15	14
Tomboy	22	23	22
RUSSIA:			
Lena Goldfields	35	32	32
Orsk Priority	8	16	21
INDIA:			
Champion Reef (2s. 6d.)	11	7	7
Mysore (10s.)	86	78	80
Nundydroog (10s.)	25	29	29
Ooregum (10s.)	25	22	22
COPPER:			
Anaconda (£10)	149	350*	347*
Arizona Copper (5s.)	32	40	40
Cape Copper (£2)	62	75	77
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	3	4	4
Great Cobar (£5)	2	3	3
Hampden Cloncurry	33	44	39
Kyshtim	42	45	49
Messina (5s.)	14	11	11
Mount Elliott (£5)	65	85	77
Mount Lyell	25	30	26
Rio Tinto (£5)	1170	1220	1235
Sissert	19	19	19
South American Copper (2s.)	15	16	15
Spassky	42	40	42
Tanalyk	41	42	45
Tanganyika	27	50	53
LEAD-ZINC:			
BROKEN HILL:			
Amalgamated Zinc	26	30	35
British Broken Hill	23	25	25
Broken Hill Proprietary (8s.)	45	59	60
Broken Hill Block 10 (£10)	21	24	23
Broken Hill North	42	48	47
Broken Hill South	145	170	167
Sulphide Corporation (15s.)	20	25	27
Zinc Corporation (10s.)	14	14	15
ASIA:			
Burma Corporation	38	52	61
Irtysh Corporation	35	40	44
Russian Mining	15	17	17
Russo-Asiatic	87	102	110
TIN:			
NIGERIA:			
Bisichi	6	9	9
Ex-Lands Nigeria (2s.)	1	1½	1½
Mongu	9	9	8
Naraguta	15	15	14
N. Nigeria Bauchi (10s.)	2	2	2
Rayfield	4	6	6
Ropp (4s.)	16	17	17
OTHER COUNTRIES:			
Aramayo Francke	27	26	27
Briseis	5	5	5
Cornwall Tailings	15	4	4
Dolcoath	7	13	12
East Pool	8	34	35
Gopeng	29	31	32
Pahang Consolidated (5s.)	7	10	11
Renong Dredging	20	30	30
Siamese Tin	52	57	55
South Crofty (5s.)	5	15	17
Tekka	60	60	62
Tronoh	30	34	30

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

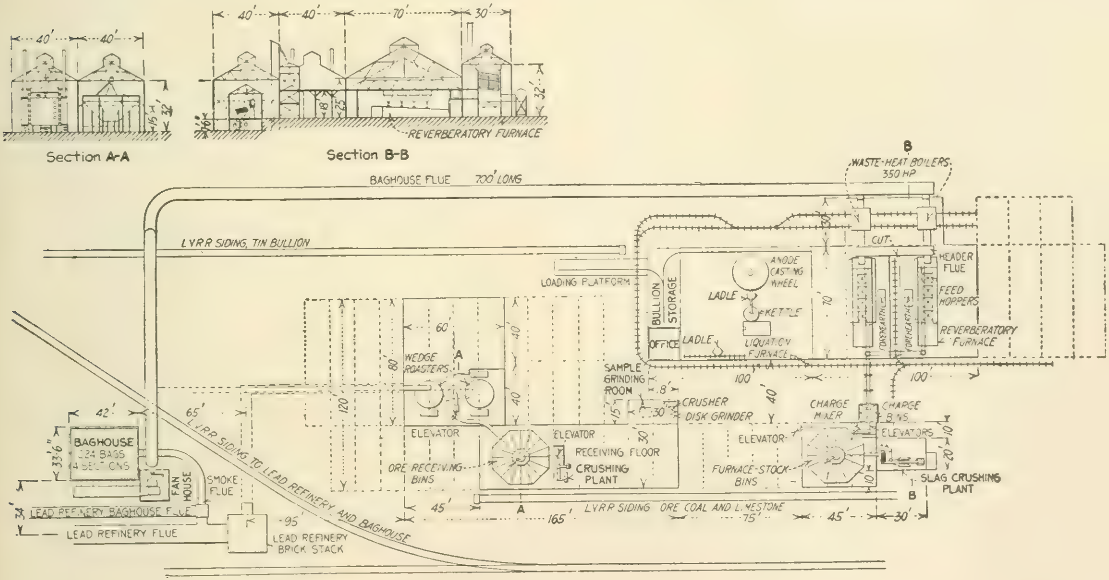
A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.]

TIN SMELTING IN AMERICA.

We have on several occasions recently referred to the establishment of a tin-smelting industry by the American Smelting & Refining Co. at the company's metallurgical works at Perth Amboy, near New York. This company is now buying much of the Bolivian tin concentrate that used to go to Germany, and in order to produce the highest grade of tin suitable especially for tin-plating and the manufacture of tinfoil, has installed an electrolytic refinery. This is the first time, as far as we know, that tin has been refined electrolytically. Hitherto there has been no necessity for such a process, for Malay, East Indian, and Australian alluvial ores have yielded sufficient supplies of purest metal, while the metal from complex ores, such as those from Bolivia, is always acceptable to the makers of tin alloys. It is interesting to note that the electrolyte in the refinery is hydrofluosilicic acid, so that the process is analogous to the Betts process for refining lead. In the *Engineering and Mining Journal* for May 27, Richard H. Vail gives a general description of the new works at Perth Amboy. Before quoting this description we may say that the smelting is in charge of E. V. Pearce, and the electrolytic department in charge of R. L. Whitehead.

The concentrate as received is delivered to a closed steel bin of polygonal shape, divided into 16 radial pockets. The lower end of each pocket is provided with an 8 in. discharge pipe. Below these pipes is a turntable and platform scale, which carries the charge car. The car is brought under such of the discharge pipes as is desired, by moving the turntable. When the mixed charge is ready, it is sent to one or other of two Wedge roasting furnaces, each containing five muffles. The furnaces are fired with fuel-oil which is atomized by air at 24 oz. pressure. Each furnace is 16 ft. diameter and gives a complete roast to 35 tons of concentrate in 24 hours, and the sulphur and other volatile constituents of the associated minerals of the concentrate are thus removed. The roasted material is delivered to another bin having several compartments, some of which contain limestone and anthracite. From here the mixed charge is sent to one of two reverberatories. These furnaces have four charging ports as shown in the diagram. The inside dimension of the reverberatories is 12 by 38 ft. Each has two oil-burners and the oil is atomized by air at 24 oz. pressure. The normal charge is 15 tons, of which 12 tons is roasted concentrate. Smelting occupies over 5 hours, and three or four charges are treated in the 24 hours. The slag may contain 10 to 25% of tin ox-



TIN-SMELTING PLANT OF THE AMERICAN SMELTING & REFINING, COMPANY.

ide, and when sufficient accumulates it is treated separately, the final slag containing 1 to 1½% metal. The molten tin is taken to a liquating furnace, from which it drains into an externally-fired pot about 6 ft. in diameter. In this pot it is agitated by compressed air to remove the dross. The metal is then poured into anodes on a casting wheel of the Walker type. The gases from the furnaces are sent to settling flues to catch the dust, and afterward to a bag-house.

The electrolytic refinery as at present provided contains 68 vats similar in size and construction to those in the copper refinery. They are built of wood with an asphalte lining. The electrolyte is described as "mainly" hydrofluosilicic acid having a strength of 15% and containing 4% tin. Each vat holds 11,000 lb. of tin anodes. The cathode starting-sheets are ⅛ in. thick. The current density is about 12 amperes per square foot, and the deposition per ampere is about double that of copper. The anodes remain in the vats about 20 days. The refined tin averages 99·96 to 99·98%, being purer than the highest qualities of Straits and Australian tin.

VERTICAL RETORTS FOR ZINC SMELTING.

It has been known during the last half dozen years that experiments were being conducted in Germany with the object of evolving a continuous zinc-smelting process using vertical retorts. The great advantage of such a process would be the reduction of the amount of skilled labour required and the improvement in the nature and conditions of the labour, together with other economic considerations. M. Liebig read a paper before the German Metallurgical and Mining Society in 1913 describing the process and plant devised on this system by Roitzheim and Remy. He has more recently described the perfected plant, erected under these patents at the Hamborn zinc smelter of the Aktiengesellschaft für Zink Industrie vormals Wilhelm Grillo, the article appearing in *Metall und Erz* for March 22 last. A translation of this article by Oliver C. Ralston was published in *Metallurgical and Chemical Engineering* for June 1. The account of the process which we give in the following paragraphs is based partly on this article and partly on British Patents 1338 of 1912 and 732, 6771, and 9314 of 1913. Our illustrations are taken from the patent specifications.

It will be seen, by reference to the illustrations, that the retorts are mounted vertically in the furnaces. They are fed at the top through special openings, where the charge is given a preliminary heat and itself forms a seal to the rest of the retort. The ashes are discharged from the bottom by means of a convenient mechanical appliance. The condensers and prolongs (otherwise nozzles) are of the usual type, the former let into the walls of the retort horizontally, the outer ends being supported by the wall of the furnace. The condensed zinc and zinc dust are collected in the usual way, but as the condensers of a row of retorts are all on one level, the collection is much easier than is the case with the ordinary furnace having tiers of horizontal retorts. The charging and discharging are both done mechanically. The charging is done from cars travelling over the furnace, and the discharged ashes are carried away by conveyors or cars. It will be seen that the conditions of labour are much easier than with the ordinary furnace. The difficult process of charging the horizontal retorts by hand is entirely abolished, as also is the objectionable duty of removing the residues from the hot retort. It is estimated that the labour force will be halved, and that for most of the work only unskilled labour will be required. The prolongs, as in the case of the modern German practice, are divided down the middle, and the carbonic oxide and other gases evolved during smelting are not discharged into the air but sent to the stack and burnt. The retorts are arranged in two rows back to back, with a central brick chequerwork between, and in a full-sized furnace there would be 40 retorts, 20 in each row. The life of the retorts is much longer than that of the horizontal retorts. For one thing the temperature is uniform, and for another there is no rough usage in charging and discharging. As the process is continuous, with no intervals for cooling and discharging, the capacity of the retort is much greater.

In looking through the British patent specifications mentioned above, it is clear that the application to

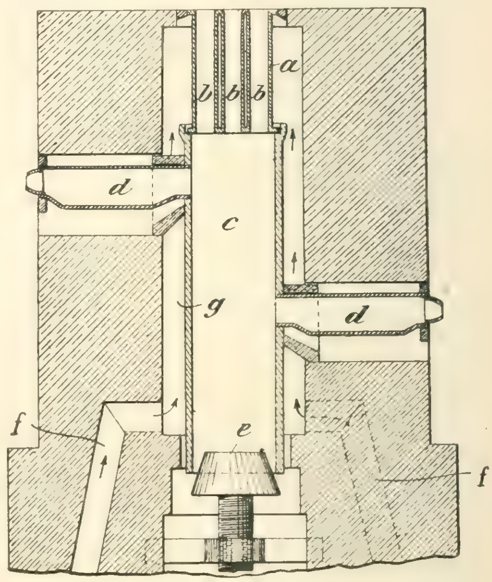


Fig. 1. Showing Preliminary Heating Device

zinc smelting of the continuous vertical retort or muffle-heated from the outside is not patentable, and that the Roitzheim and Remy patents relate to methods of overcoming difficulties in practice. It will be seen also that the retorts illustrated have two condensers, one on each side; whereas in the description by Liebig mention is only made of one condenser. The translation of Liebig's paper published in *Metallurgical and Chemical Engineering* is accompanied by a photograph of the furnace, but the picture is so black and blurred that it shows nothing.

In Fig. 1 herewith is reproduced the drawing attached to patent 1338 of 1902. The object of the invention therein described is to provide a preliminary heater for the charge, the heating being effected without any reduction of the zinc. The preliminary heater or fitting *a* is formed with a number of small tubes or narrow passages *b*, through which the charge passes.

These are surrounded by the flames within an extension of the furnace. The large contact surfaces and narrow cross-sections of the tubes enable the mixture to be quickly and completely heated. From the preliminary heater the material descends into the retort *c* below. The condensers are shown at *d*. The residue is continuously or at short intervals removed at *e*. The mixed materials sink gradually in the retort. The hot gases for heating the retort ascend from the ports *f* along the annular space *g* and then escape through an opening near the top of the furnace.

Patent 732 of 1913 (Fig. 2) relates to a method of keeping the discharge end of the retort clear of obstruction. In practice it is found that the residue hardens on the walls of the retorts, where they project out of the furnace. At the lower mouth of the retort a rim of slag is formed which would constrict the opening and finally entirely close it if arrangements were not made for its removal. The invention consists of means for cutting away or removing these crusts. The retort *a* is preferably of circular section at its lower mouth, and it is mounted on the support *b*. A rotatable cutter *c*, such as a milling-cutter, or a borer or scraping tool, is mounted on the square shaft *d*. The lower end of this shaft carries a toothed rack, shown at *e*. A pinion *f*, which is rotated by means of a crank handle, meshes with the teeth of the rack, so that the shaft *d* can be elevated and lowered by it. The shaft *d* is held as in a guide by the spindle *g*. This spindle carries the worm *k*. The quantity of charge travelling through the furnace can be regulated by varying the speed and pitch of the worm. The spindle *g* is driven by worm gears *l*, l^1. The support *b* is provided with a cooling device, comprising the chamber *m* and the water supply and discharge pipes *n*. A chute *o* is also provided.

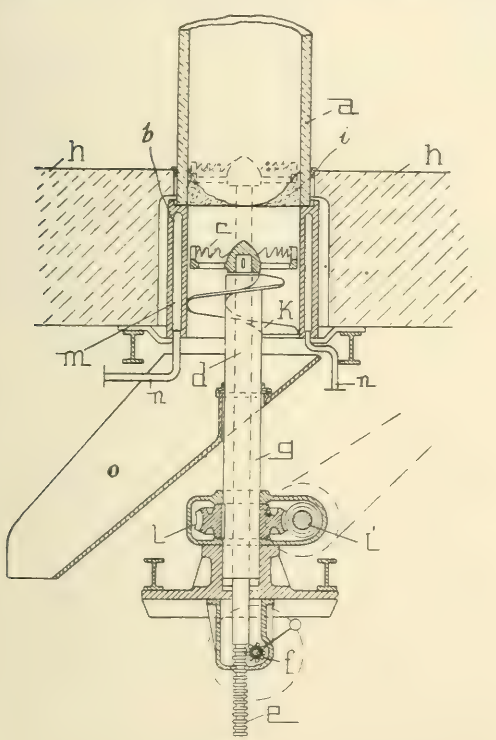


Fig. 2. Scraper for Keeping Bottom of Retort Clear.

Patent 6771 of 1913 (Fig. 3) is concerned with a method of cooling the lower part of the retort, so that the discharged residue shall not contain vapours. If the residue is discharged hot, vapours of lead, zinc, and sulphur are given off, greatly to the discomfort of the workers. The illustration shows vertical retort *a* in a furnace *e*. A jacketted vessel *b*, made of a suitable metal, is fixed at the bottom. Between its double walls a current of water or steam flows, so that an effective cooling is obtained. The vessel is held tightly against the lower edge of the retort, so that it may be considered to form an extension of the retort. It is closed below by a gate, or as shown in the drawing by the residue heaped on the conical plate *c*. This plate *c* is secured to a screw *i*, which screws in the stationary plate *k*, whereby the said conical plate *c* can be raised or lowered. The pipe *d* supplies the cooling water, which flows through the jacket space *g* between the walls of the vessel *b* and runs out through suitable outlet pipes into a discharge or gutter *f*.

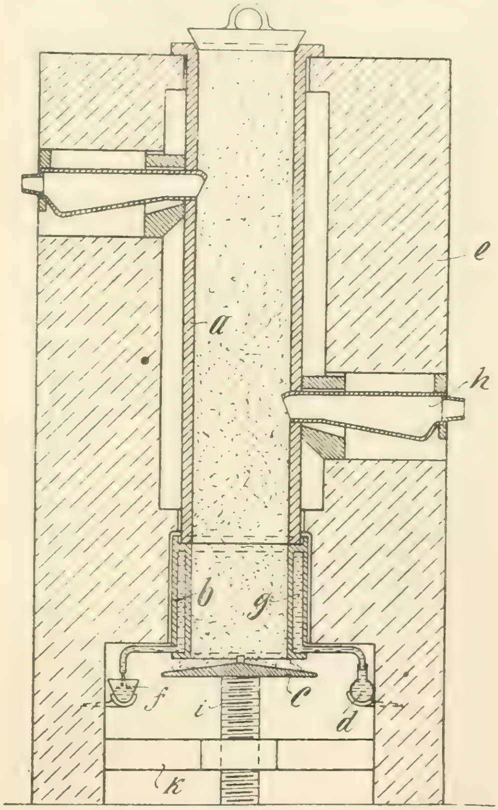


Fig. 3. Cooling Device for Discharge End.

Patent 9314 of 1913 describes internal arrangements within the retorts for facilitating the escape of the gases and vapours and need not be quoted at length.

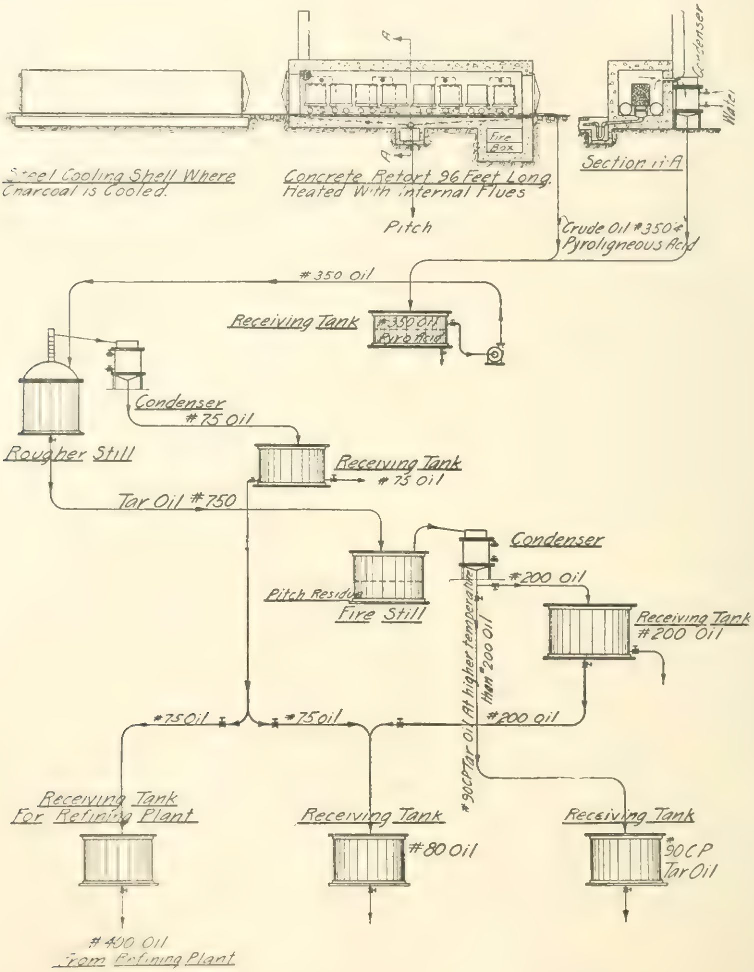
In examining the illustrations it is well to remember that they are merely sketches and not necessarily working drawings; also that the descriptions in the patent specifications do not necessarily represent the actual practice. In several ways the descriptions in Liebig's article do not tally with those of the specification, notably in the number of condensers used.

MANUFACTURE OF PINE OIL FOR FLOTATION PURPOSES.

In the early days of the Minerals Separation agitation-froth process, oleic acid was used as frothing agent. It was not, however, the ideal agent, as its use involved the heating of the pulp to a comparatively high temperature, and the use of a large quantity of sulphuric acid to prevent saponification and emulsion of the oil in the presence of the ore. To obviate these disadvantages, the Australian investigators sought substitutes, and Henry Lavers found that eucalyptus oil gives greatly improved results. Less quantities are necessary, the amount of sulphuric acid is greatly reduced, and the temperature of operation is much lower. The American metallurgists would no doubt have used eucalyptus oil if any supply had been available, but the tree is not common there, and it was not economical to buy the oil from Australia. Consequently metallurgists and makers of oils have had to seek other oils with similar characteristics. Various products of distillation of the resinous pine, which grows on the coast of the southern Atlantic and Gulf States, have been employed with success.

We take the following description of the distillation process from the pamphlet of the Pensacola Tar & Turpentine Co., of Gull Point, Florida; and we would say that a fuller description of the process is to be found in the 3rd Edition of T. J. Hoover's 'Concentrating Ores by Flotation' now in the press.

Dried wood from which the sap has been evaporated is employed, and it is said that 1000 lb. of oil can be obtained from a 'cord' of wood measuring 64 cubic feet. The distillation plant presents several points of novelty. A sketch of this apparatus and flow sheet are shown in the accompanying illustration. The retorts are of heavily reinforced concrete, with 15 in. walls, and are 96 ft. long, holding eleven cars of wood of one cord capacity each. These cars are of all-steel construction, and are left in the retort with the wood throughout the process. The retorts are heated with internal flues from furnaces fired with fuel-oil and the combustible gases formed in the distillation. The wood is subjected to temperatures which distil all of the resinous material, leaving nothing but char-



DIAGRAMMATIC FLOW-SHEET OF PENSACOLA PLANT FOR PRODUCING PINE OIL.

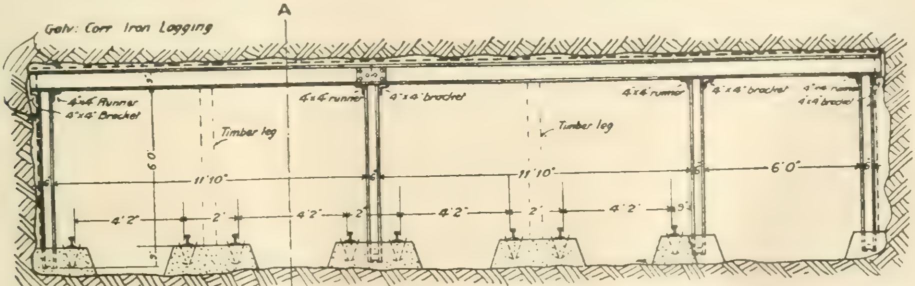
coal on the cars. The amount of charcoal is 35 to 40 bushels per cord. By careful control of temperature there is produced from the bottom of the retorts 250 lb. or more of pitch per cord of wood, thereby yielding a crude oil from the condensers with a lower pitch base than most other destructive distillation processes. This is important, as experience has shown that heavy pitch base oils are gangue lifters. The process is as follows: After a period of complete distillation, the doors of the retorts are opened, a chain is attached to the pulling cable at one end and to the train of cars of wood at the other, and the eleven cars of charcoal are pulled into the cooler at the same time that eleven fresh cars of wood are pulled into the retort. The doors, which are fitted with air-tight joints, are closed, heat again turned on, and in a very short time the condensers begin to flow. The liquor coming off from the condensers is composed of water, crude pine oil, and pyroligneous acid. This acid water, containing about 4% of acetic acid, is run to waste after settling. The crude oil, which contains the crude wood turpentine, crude pine oils, wood creosote oils, and tar oils, is pumped to a large roughing-off still. This still contains copper heating coils and a system of steam jets. The lightest product is a wood naphtha. Though an excellent selective agent, it is too volatile to be used as a flotation medium, and the small quantity contained is rapidly removed by the aid of the steam coil. When this is driven off, distillation is continued by using both the steam jets and the coil, the crude wood turpentine, pine oil, and a small quantity of wood creosote oil being driven off. The steam still will not economically drive off any of the higher temperature and heavier oils, so the material is, after a time, emptied into a large copper fire still, where the temperature is raised. In the first instance the wood creosote is removed, and later when the temperature is carried higher the tar oils are distilled off.

Tests on the various products from Southern pine are given in the table below; the constants shown with the list of oils may vary slightly, but probably not enough to affect their value as frothing agents. Being mostly crude products, they do not have the same accurate and positive constants as well refined oils. With the exception of No. 15 and No. 1580, they are explained in the flow-sheet. No. 15 is a thin rosin oil, reported to be a good frothing agent. No. 1580 is a mixture of this and No. 80, and is on many ores an excellent selective agent, as well as a good frothing agent.

No.		Sp. Gr.	Distillation Points, C.	Refractive Index	Viscosity
75	Crude wood turpentine	0·887	65–217	1·456	0·9
80	Crude pine oil	0·911	70–232	1·4894	1·1
90	Redistilled pine tar oil	0·982	160–368	1·5636	5·8
200	Refined wood creosote oil	0·965	105–275	1·5096	1·7
400	Crude wood creosote oil	1·025	190–360	1·4977	2·9
15	Special thin rosin oil	1·017	170–368	1·5631	6·1
350	Special crude pine wood oil	1·019	70–345	1·5[illegible]5	2·9
1580	Combination pine oil	0·980	85–352	1·5361	2·3

CONCRETE FOUNDATIONS FOR MINE RAILS.

At the Central incline shaft of the Bantjes mine in the western Rand the rails are laid on concrete stringers instead of timber sills. An account of this shaft appeared in our issue of November last when a note was given of the method of recovering the shaft after the collapse in December 1915. The April number of the *Journal* of the Chemical, Metallurgical, & Mining Society of South Africa contains a paper by W. W. Lawrie and G. Hildick Smith describing the method and cost of forming these concrete stringers and the advantages gained thereby. The shaft measures 33 ft. by 7 ft. 6 in., and dips at an angle of 34½°. The accompanying illustration shows the stringers and the steel sets. The rail gauge is 4 ft. 2 in., and the rails weigh 60 lb. per yard. The middle stringers carry two rails, one for each car, and are 2 ft. 9 in. wide at the top with a batter on the sides of 65°. Their depth depends on the irregularities of the foot-wall, and averages 1 ft. 9 in. Construction of the stringers is commenced at the bottom of each section to be built. Boxing of a length of 18 ft. is placed in the shaft in the right position and at the correct grade. Wooden blocks are bolted to the boxing so as to form the holes in the concrete required for the rail bolts. At the bottom of these blocks are slots for longitudinally placed iron bars 3 ft. long and 1½ in. diameter which are embedded in the concrete. The use of these bars is to hold the hooked lower ends of the rail bolts. The wooden blocks are 4 ft. apart, thus making the rail bolts at this distance apart. The concrete is made of 6 parts of unwashed development rock, either quartzite or reef, but not dike matter, to pass 2 in. screen, and 1 part Pretoria Portland cement. One white man and 9 natives can build an 18 ft. section in one shift. The cost of this labour is 22s. 6d. for the white man and 24s. 9d. for the 9 natives, being a total of 47s. 3d., or 2s. 7½d. per foot. The cubical content of 1 ft. of stringer averages 5½ cu. ft., of which one-seventh is cement, that is, 0·75 cu. ft. per foot or 13·5 cu. ft. for the 18 ft. section. It is found in practice that 10 bags of cement at 6s. 6d. per bag are required for the 18 ft. section, making the cost of cement 65s. per section or



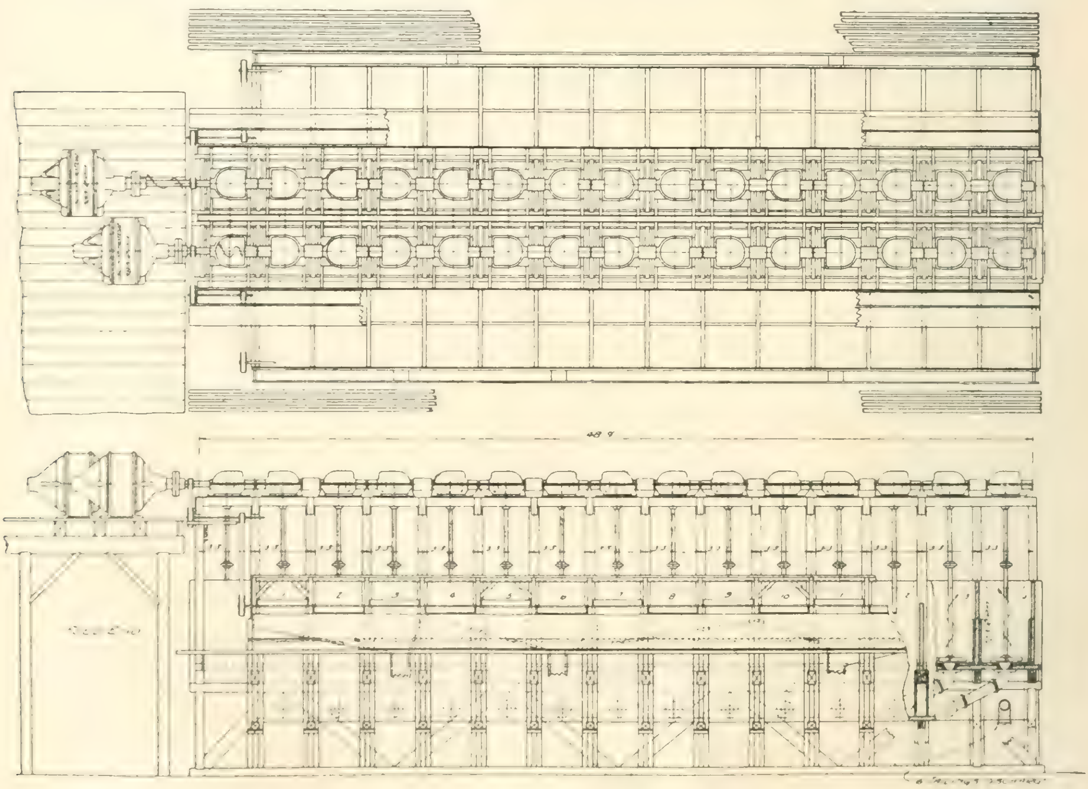
Cross-Section of Bantjes Central Shaft, showing Position of Concrete Foundation for Rails.

3s. 7d. per foot. The total cost per foot of stringer is thus 6s. 2½d. Across the shaft there are 4 full-sized stringers and one of half-size, so that the cost of laying the stringers per foot of shaft is 28s. At the Nourse mine, under similar conditions, timber sills cost 49s. per foot of shaft, so that the cost of the concrete is much lower.

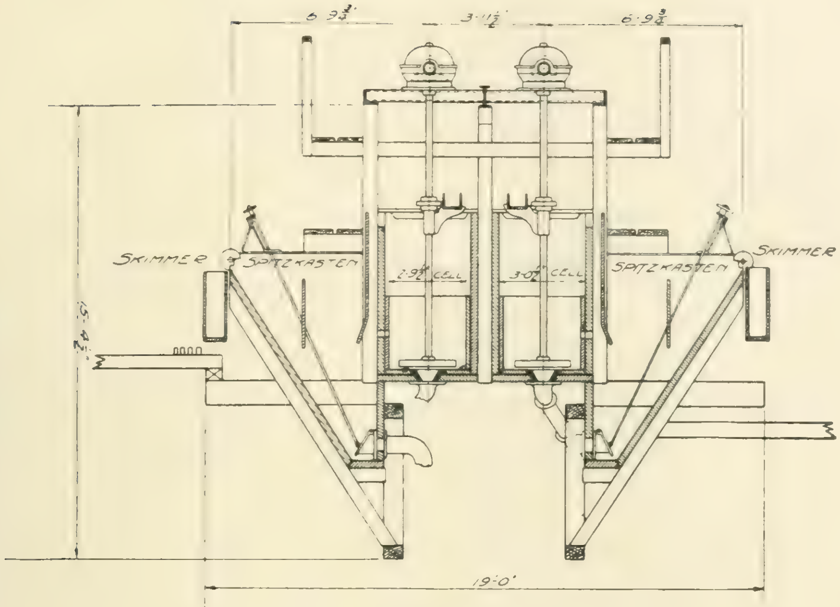
In comparing the relative advantages of concrete stringers and timber sills, it must be remembered first of all that the use of concrete is not advisable where there is danger of movement of the foot-wall. Where there is no such danger, the advantages of the concrete are many. A longer life is assured to the rails, which can be allowed to wear down to a greater extent than with wooden sills. Skip derailments cause much less damage. Concrete lasts longer and is not so liable to injury. Less time is occupied in equipping the shaft owing to there being no long timbers to handle. One pair of skip roads may be completed first, so that hoisting can be started before the whole of the shaft is equipped, an important point in connection with a deep shaft.

MINERALS SEPARATION PLANT AT ANACONDA.

In our April issue we quoted at some length from Messrs. Laist and Wiggin's paper, presented to the American Institute of Mining Engineers, describing the tests of the Minerals Separation flotation process at Anaconda, and the modification of the concentration plant following on the adoption of the process. In the June *Bulletin* of the Canadian Mining Institute there is published a short paper by E. P. Mathewson, of Anaconda, giving an outline of the remodelled plant. This paper contains detailed drawings of the Minerals Separation plant. These we reproduce herewith, and we append a few explanatory notes. The drawings show a double machine, each machine being run as a separate unit. The feed is introduced into a preliminary agitator-box at the motor end of the machine, from which it passes through an opening in the partition to the first of the series of 14 agitation and frothing boxes. The agitated pulp passes into spitzkasten at the sides, and the froth concentrate is skimmed off by means of a paddle, the remaining pulp being passed through a pipe, which is controlled by a valve, into the second agitation-froth compartment and spitzkasten. The action is here repeated, and so on throughout the series of fourteen. The first four (sometimes seven) of the spitzkasten give a finished concentrate, and the remaining spitzkasten a middling which is returned to the system. Each line-shaft is driven by a 150 hp. motor at 385 r.p.m. The vertical shafts carrying the agitating impellers revolve at 223 r.p.m. The impellers are 2 ft. in diameter, and



Plan and Elevation of Minerals Separation Plant at Anaconda.



CROSS-SECTION OF MINERALS SEPARATION CELL.

consist of four blades placed at an angle of 45° to the vertical. Each pair of impellers is arranged so that they revolve in opposite directions so as to balance the side thrust on the line-shafts. The impeller shafts are driven by bevel gear running in grease, and they are supported both vertically and horizontally by ball-bearings. When the pulp is hot, that is over 100°F., it is advantageous to place the motors at the discharge end, so as to avoid contact with the motors of the steam rising from the pulp.

THE ORIGIN OF CHILEAN NITRATES.

Economic Geology for March-April 1916 reprints a paper by J. T. Singewald and B. Leroy Miller, presented to the Second Pan-American Scientific Congress, discussing the origin of the nitrate deposits of Chile. The authors examine each of the theories hitherto propounded, and afterward proceed to give a theory of their own. We will first quote their outline of the older theories. Here we would interpolate the remark that the older theories were published at a date earlier than the discovery of the great deposits of Chile, and had reference to deposits in southern Peru.

One theory propounded in 1867 by Noellner holds that the deposits owed their origin to the accumulation of great quantities of seaweed along the coast; afterward an uplift of the land raised this seaweed together with entrapped sea-water. The reaction of the sodium chloride of the evaporated sea-water with the nitrogenous contents of the seaweed is held to account for the sodium nitrate. The great argument in favour of this theory is that iodine compounds are found in the nitrate, and that the only other known source of iodine is sea-weed. Otherwise the theory has no important argument in its favour.

According to a second theory the nitrates are due to extensive deposits of guano along the banks of a salt sea. When the saline waters flooded the guano, the interaction of the sodium salt of the sea and the calcium nitrate of the guano caused the formation of sodium nitrate. This theory was advanced by Hillinger in 1860 and by Gautier in 1894, and was amended in 1887 by Ochsenius. Phosphates are important components of guano, but are entirely absent from the nitrate beds, and to account for their absence Ochsenius evolved the idea that the guano was blown from islands in the Pacific, the heavier phosphate particles being lost on the way. In 1903 Ochsenius withdrew this theory and adopted the view that the nitrate was formed by the oxidation of the nitrogen of the air. Penrose in 1910 (see *Journal of Geology*, Jan.-Feb. 1910) gave his opinion that the nitrate region was at one time part of the ocean bed, and later an interior basin occupied by salt lakes; guano deposited on the borders of these lakes was the origin of the nitrates, which were carried down into their waters. He got rid of the phosphate difficulty by suggesting that the phosphate may actually exist in the unexplored pampas.

A third theory is based on the action of bacterial organisms, and was proposed in 1862 by Pasteur. In 1896 William Newton elaborated this theory. He ascribed the genesis of the nitrate to the action of the nitrifying organisms on ancient vegetable matter in the soil, the nitrate thus formed being collected by drainage waters, and evaporated at the point where the waters were stopped by the coast line of hills.

An electrical theory mentioned by various writers accounts for the formation of nitrate by the oxidation of atmospheric nitrogen caused by electrostatic discharges from the rolling coast fogs. Other writers have pointed out that the electrical storms round the summits of the Andes may account for the oxidation of the atmospheric nitrogen.

The present authors consider all these theories insufficiently supported by evidence, and they have presented another explanation. Briefly their view is that the deposits have resulted from the accumulation by means of evaporation of the minute nitrate content of the underground waters of the region. In other words that they represent a sort of efflorescence of soluble salts out of the ground-water. This accumulation has been possible owing to the unusual relations of ground-water and climate in this region.

The authors proceed to elaborate their theory and to explain the conditions existing in the region. The nitrate area is one of the most arid on the face of the earth. In some parts rain hardly ever falls, and the intervals between falls of rain are measured in terms of years. The prevailing westerly winds coming from the Pacific drop most of their moisture in crossing the zone of the cold Humboldt current that lies just off this coast. As they are warmed again on reaching the coast and blow across the pampas, they are deficient in moisture and consequently have a strong power of evaporation. Also the occasional winds that come down from the Andes have lost nearly all their moisture in the cold high summits of that range; and, as they reach the pampas, they absorb any moisture with which they come in contact. A hot tropical sun shining from a cloudless sky is an important adjunct in intensifying this aridity. It is true that as the temperature falls at night heavy fogs from the sea, known as the 'camanchacas,' frequently roll over the coast range and cover the pampas; but, as soon as the rays of the sun strike this fog, it vanishes at once. The pampas are consequently a dust-covered surface on which no vegetation is seen, overlain by an atmosphere the powers of evaporation of which are at a maximum.

In a country of such aridity and at an elevation of several thousand feet, we should normally expect to find the depth of ground-water to be measured in hundreds of feet. One of the remarkable features of this nitrate region is the shallow depth at which ground-water is found, the depth being measured in tens of feet. For instance, over the nitrate-bearing ground of the Oficina Paposas at La Noria, the depth of ground-water is only 20 to 25 ft.; and in a 'salar' or 'salt pan' at Lagunas, it stands in open ditches at a depth of little more than 3 ft. The pampas have been built up with loose porous detrital material washed down mainly from the slopes of the Andes on the east. Through such material, capillarity is effectively feeding the shallow ground-water in enormous quantity to the atmosphere through evaporation. Whatever soluble salts this ground-water is carrying are left behind to accumulate in the soil between the surface and the ground-water level.

However great this loss of ground-water may be, the supply is incessant and ample. There is a constant flow of ground-water from the regions of more abundant precipitation in the higher slopes of the Andes on the east, passing westward beneath the pampas, toward the sea. The pampas have a gentle westward slope to the foot of the coast range, where the mountains cause an abrupt rise in the surface and the ground-water. As the ground-water follows the surface of the land in its general outlines but is less accentuated than the latter, the ground-water level should lie nearest the surface on this western edge of the pampas; and consequently here should take place the maximum evaporation, and for that reason, the maximum accumulation of soluble salts occurs here.

The nitrate deposits are by no means uniformly distributed over the whole pampas, but are practically limited to the western edge. Even along this western edge the deposits are not continuous, but occupy restricted areas, and their topographic position is not always the same. In the southern and central part of the Tarapacá field, the nitrate areas tend to occur around the 'salars,' which are depressions in the pampas characterized by an abundance of salt and absence of nitrate. The richest nitrate ground is frequently that immediately contiguous to the salars, and the nitrate tends to decrease in quantity with increasing distance and elevation above the salar. There are often small knolls within a salar, and these also carry nitrate above its level. In the northern part of the region the nitrate tends to occur on the lower slopes of the hills that rise abruptly out of the pampas, and not on the pampas themselves. The nitrate is found where the rise of the hills begins and diminishes in quantity with increasing elevation.

The fact that the nitrate occurs around and not in the salars is easily understood, in view of the deliquescent nature of this substance. Suppose that salt and nitrate had accumulated in these depressions. When a rain did come, or when the pampas were deluged, as they occasionally are, by torrents bursting down from the Andes, these would be the places for the waters to collect before they had been completely dissipated through seeping into the soil and by evaporation. They would be the wettest places and the last places to remain wet. Whatever nitrate existed there would be taken into solution, and it would at once begin to effloresce out of the boundaries of the salar, and accumulate in the dry ground surrounding it. This process repeated at intervals would keep the salar free of nitrate, and leave the accumulation of salt behind. The manner of occurrence in the north pampas is such as would take place if the pampas were covered by a relatively impervious stratum, such as a layer of fine silt, that would reduce evaporation of ground-water to a minimum. The belt of maximum evaporation would then be in the more porous ground lying just above the pampas level where ground-water would be nearer the surface than farther up on these slopes. Nitrate ought to be most abundant at the foot of such slopes and decrease in quantity upward, which is actually the case.

Coming back to the conditions existing at the upper surface of the ground-water, we have it subjected to a constant evaporation with a rapidity dependent on its nearness to the surface and the porosity of the overlying soil. Though the amount of this evaporation, on account of the aridity of the climate, is great over the whole extent of the pampas, in general it is not sufficiently so to admit of the accumulation of the soluble salts; or, if they do collect, the ground is washed out frequently enough in the eastern part of the pampas, by descending rain waters and the waters of the mountain torrents that flood it, to carry the salts back into the general ground-water circulation. This evaporation of the upper layers of ground-water leads to a concentration of the soluble materials that they carry; but counteracting this tendency to concentration is the slow seaward movement of these waters and the downward diffusion from the concentrated layers to the lower more dilute layers. Under most conditions, these dissipating influences are sufficiently strong to prevent the point of saturation being reached in the upper layers. As the western edge of the pampas is reached and the ground-water comes nearest the surface, the amount of evaporation increases rapidly; and where a particularly porous area exists, it reaches a maximum. To compensate this loss by evaporation, there is a constant influx of water which more than counterbalances the tendency of the westward flow and downward diffusion to equalize the concentration. Finally the concentration reaches such a degree at these places that an efflorescent salt like sodium nitrate will begin to crawl out of the solution, as it were, and be deposited in the overlying soil. This process, long continued, will lead to accumulations of large deposits of sodium nitrate, irrespective of how minute a quantity the original ground-water carries. At these places will accumulate a large part of the nitrate collected by the ground-waters from the entire surrounding region. Sodium chloride, having a weaker tendency to effloresce, will not be accumulated as readily, and hence will exist in a smaller relative quantity in the accumulated salts than in the original waters, and may not occur at all at some places.

ASSAYS OF COMPLEX TIN ORES.

The quarterly *Proceedings* of the Australasian Institute of Mining Engineers, 1916 No. 21, contains a paper by A. M. Matheson, giving details of his experience relating to the reliability of the vanning and fire method of estimating tin in highly pyritic ore. He compares this method with the chemical assay on the same ore, and shows how its employment fails to give reliable estimates of mill recovery and loss. The ore on which he experimented contained the tin as cassiterite. The associated minerals were, besides pyrite, sulphides of arsenic, antimony, copper, and lead. Stannite, the sulphide of tin, was probably present, but as it was dissolved in the preliminary acid treatment, it would not play any part in either the chemical or fire assay. The saleable concentrate averaged 71% Sn, 0·29% Pb, 0·31% S, and 0·1% As.

The fire assay used was that of vanning after digestion, and fusion with cyanide. The chemical assay was the Pearce-Low method, as follows: 0·5 grammes of finely ground ore is digested with aqua regia and filtered, the filter paper and contents ignited, and fused in a nickel crucible with NaOH. The cake is dissolved with water and about 30 cc. HCl, transferred to a conical flask, and 50 cc. excess HCl added. A strip of nickel is inserted, and the solution boiled for 1½ hours; the stannic chloride is thus reduced to stannous chloride. The nickel is then removed, a piece of carbonate added to prevent oxidation, and the assay cooled and titrated with standard iodine solution with starch indicator.

The three products under consideration in the following assays were: (1) battery pulp, (2) tailing from primary treatment, (3) tailing from secondary treatment.

(1) The battery pulp gave the following assays by the two methods:

Fire Assay %	Chemical Assay %	Ratio of Chemical to Fire
1·29	2·48	1·92
1·20	2·10	1·75
1·70	3·14	1·84

(2) The following were the results with primary tailing:

Fire Assay %	Chemical Assay %	Ratio of Chemical to Fire
0·10	0·84	8·40
0·19	1·03	5·42
0·12	0·96	8·00

The recovery by fire assay (about 14·5%) was very much lower than would be expected. But in making a comparison between this recovery and the recovery of 50% in the pulp product, it must be remembered that all the easily recoverable oxide had already been taken out by the plant and only the very fine slime concentrate left for vanning. In the fire assay 100 grammes of ore was taken for vanning. Although quite an appreciable amount of oxide was obtained, the resulting tin button was very small indeed (in some cases only about 20% of the oxide obtained), showing that a further loss took place in the fusion, the tin oxide going into the slag probably in combination with the silica as stannous silicate.

In vanning this tail product it was not possible to get rid of all the silica without making a very great loss of oxide. It became questionable, however, whether the loss made in thoroughly cleaning the oxide would be greater than the loss in the fire when smelting in the presence of silica. The writer came to the conclusion, after numerous experiments, that a 100 grm. charge of this product was much too large to handle without a great loss, so a 10 grm. charge was tried, with the following results:

	% Sn.
Chemical assay	0·84
Oxide obtained	0·60
Metal estimated at 70%	0·42

This shows a recovery of 50% of the chemical value by vanning. The oxide obtained in this case was considered too small a quantity to smelt, and was estimated at 70% metal.

Considering the loss that must have taken place in vanning this oxide clean, and the subsequent loss that would have taken place in the fire if smelted, it seemed reasonable to suppose that the oxide actually weighed should equal 70% metal or more. It seemed almost impossible to reach anything like finality in vanning this tail product, a fair proportion of the tin oxide always remaining in suspension even after long settlement. A grading analysis carried out on this product, having a bulk chemical assay 1·24%, resulted as follows:

BULK CHEMICAL ASSAY, 1·24%.

Mesh	Grade	Assay	Product	Tin Percentage	
−20	—	—	—	—	—
+40	—	—	—	—	—
+60	29·8	1·00	29·8	29·0	—
+80	22·5	0·80	18·00	17·60	—
+100	7·0	0·60	4·20	4·10	—
+120	17·30	0·60	1[illegible]·40	10·20	—
−120	23·40	1·72	40·30	39·10	—
Total	100·00	1·24	102·70	100·00	1·03

The result of this grading analysis does not check with the bulk assay as might be expected, but the low result is most probably due to the mechanical (filtration) loss that takes place, more especially in the finer grades.

(3) The assays of secondary tailing was:

Fire Assay %	Chemical Assay %	Ratio of Chemical to Fire
0·24	0·68	2·84
0·15	0·48	3·20
0·18	0·52	2·90

These showed a very low recovery by fire assay. A 100 grm. charge was used in vanning for the fire assay. This was also a difficult sample to van. When a 10 grm. charge was used in vanning the results were as follows:

Fire Assay %	Chemical Assay %	Ratio of Chemical to Fire
0·40	0·80	2·00
0·36	0·60	1·66
0·30	0·56	1·87

These assays show a much better recovery by fire, but the vanning and fusion losses are still considerable.

In order to find out what extraction might reasonably be expected from a slime table operating on these two tail products (2) and (3), the following vanning experiments were carried out, the conditions being as near as possible to those obtaining in actual work:

(1) Vanning primary tailing for 15 minutes without acid treatment, and in dirty water, chemical assay value, 1·24% Sn. The pyritic concentrate obtained was acid treated, resulting in oxide equal to 0·70%, estimated metal 0·49%, showing that the table might be expected to save about 40% of the tin content.

(2) Vanning secondary tailing for 15 minutes without acid treatment, and in dirty water, chemical assay value, 0·88%. Oxide obtained 0·60%, estimated metal 0·42%, showing that the table might be expected to save about 48% of the tin content. It may be mentioned that a Cornish round table is now operating on this tail product, and has made an average saving of 50%.

In these products under consideration it will be noticed that the tin contents vary greatly; this condition seems to be consequent on physical changes in the ore in the mine. The more pyritic the ore becomes the greater are the losses in the tailing from primary treatment. The chemical assay records these physical changes faithfully, while the vanning and fire assay, even if carried out carefully, fails almost completely to show these changes. Before the introduction of the chemical assay by the writer, these mill losses were estimated by fire assays, and it would appear that they were carried out with more regard to speed than to accuracy. Records taken over some years show little or no variation. The extraction by the plant, estimated by these fire assays, would be anything from 90 to 97%, which is altogether too high to expect from even the most up-to-date plant on this class of ore. The extraction estimated by the chemical assays is much lower, and certainly much nearer the truth, but does not necessarily show that the plant is not doing good work.

When nickel became unprocurable owing to the war, iron in the form of horseshoe nails had to be used as a reducer in the chemical assay. The results occasionally were low and unreliable, probably due to oxidation taking place. HCl acts much more readily on iron than on nickel, and consequently less iron had to be used. Apparently all the acid of the assay was used up in the formation of ferrous chloride, none being left to form CO_2 with the carbonate, and oxidation appeared to have taken place.

The following assays were carried out, varying the number of nails used to test this suspected oxidation. These assays were carried out on a pulp sample, the correct assay of which was 3·08% Sn:

(1).—4 nails...1·48% Sn. (3).—2 nails...3·08% Sn.
(2).—4 „ ...2·52% „ (4).—2 „ ...3·08% „

Oxidation did not always take place with four nails, but the results were low and unreliable. A considerable number of tests were carried out on different samples of a similar product, and a few are here quoted: Nos. 1, 2, 3, and 4, and 3·28%, 3·24%, 3%, 3%, using two nails each. Using two nails only the results became constant and reliable, there being sufficient free acid left in the assay to form CO_2 with the carbonate and prevent oxidation. A further test was made on sale concentrates assaying 70% Sn by the fire assay; (1) one nail gave 63·07%, and (2) two nails gave 69·74%.

The following assays on the pulp and tailings show the results of using too much iron:

(1). Mill pulp: 4 nails, 0·74%; 2 nails, 1·26%.
(2). Primary tailing: 4 nails, 0·52%; 2 nails, 0·70%.
(3). Secondary tailing: 4 nails, 0·36%: 2 nails, 0·78%.

According to some authorities, the chemical assay gives high results, and certain impurities tend to make results high, but that had not been the experience of the writer. Sale concentrates, which must necessarily contain all the heavy impurities of the original ore, concentrated, invariably give slightly low results as compared with the fire assay. These impurities must have, therefore, little effect on the assay of the pulp and tail products.

In particular it has been stated that wolfram interferes with the chemical assay and gives high results. The following test was made on an ore assaying 30% WO_3 and 4% Sn. This was treated as an ordinary tin assay, using iron as a reducer, with the result that the assay assumed a deep blue colour shortly after reduction commenced, owing to the formation of a tungstate. Titration with iodine was impossible. However, the obvious thing to do with an ore carrying any tungsten would be to extract the H_2WO_4 with ammonia, evaporate the ammonium tungstate, and estimate as WO_3, then proceed with the residue on the filter as a tin assay.

The writer does not contend that the chemical assay should take the place of the vanning assay in estimating mine samples. The latter is shorter, and certainly serves as a guide as to what should reasonably be expected from the mill; however, the estimation of the oxide obtained after acid treatment and careful vanning should be near enough, taken at 70% metal, without going to the extra trouble and expense of smelting, knowing that a further loss in the fire is almost sure to take place. For instance, in the case of the Cornish table previously mentioned, where vanning assays gave an expected extraction of 48%, the table when installed actually saved 50%. It is evident, therefore, that as a guide to mill work the vanning assay has its uses.

Lead-Zinc Ores of the Transvaal.—For many years deposits of lead and zinc ores have been known and intermittently worked at Ottoshoop, to the south of Zeerust in the western part of the Transvaal, and not far from Mafeking. The deposits are found in the dolomite of the Transvaal System, which overlies the Witwatersrand System, and is of Pre-Cambrian age. These deposits and their origin form the subject of a paper by the late William Anderson, published in the *Transactions* of the Geological Society of South Africa for 1915. The ores have two modes of occurrence, in pipes and as disseminations respectively. As regards the first mode, a great number of pipes have been found, varying in width from 50 to 300 ft. or more, passing upward through the dolomite and through intercalated beds of chert. These pipes have no surficial connection. They are surrounded with rims of metamorphosed and hardened rock, which have resisted weathering to a greater extent than the rest of the rock and stand a few feet above the surface. Within the rims the dolomite and chert are much broken and the interstices are filled with galena, zinc-blende, pyrite, calcite, and other minerals in varying proportions. The dolomite is altered to tremolite at many points. In the second mode of occurrence, the minerals are found disseminated in patches, with no indication of any pipe, and the dolomite is not tremolitized. As regards the origin of the deposits, there appears to be no reason to doubt that the minerals came from below in hot solutions, and that in the case of the pipes the geyser action caused the alteration in the walls. At the surfaces of the pipes there are enrichments which may have been caused by the rising solutions not being able to pass farther upward through impermeable slates of the Lower Pretoria series, which extended over the dolomite in the earlier geological ages. As regards the disseminated deposits, the galena and zinc-blende appear to have been formed as replacements of nests of calcite contained in the rock. In discussing conditions further, the author shows that the rising solutions selected the dolomite in preference to the chert as the medium for the crystallization and dissemination of their contents, and that the metamorphism of the dolomite into tremolite was at an earlier period than the introduction of the minerals. The pipes bear a general similarity to the diamond and tin-bearing pipes of South Africa, and the author compares them to similar occurrences in Kansas and to the Mount Morgan gold-copper deposit.

Collecting White Arsenic. — At a meeting of the London section of the Society of Chemical Industry held on December 6 last, T. C. Cloud read a paper dealing with the transport of metallurgical dust. In particular he described a plant recently erected, at a works not specified, for transporting arsenious acid from the settling chambers to the packing plant. Experiments based on the household vacuum-cleaner showed that the idea was applicable to the case in hand, and a plant was erected utilizing the principle. Mr. Cloud gave a brief outline of this plant. The vacuum pump has a capacity of 20,000 cu. ft. per hour. The main pipe brings the material to a cyclone separator in the packing house, and here the bulk of the arsenic is deposited. The current of air passes through a second separator, where some of the remaining arsenic is caught. Afterward the air is drawn through a shallow layer of water. The cyclone separator is fitted with an automatic apparatus which discharges the arsenic into barrels. The smaller separator has baffle-plates and a collecting receptacle, and the deposit is discharged at intervals, when the vacuum-pump is not working. At various places in the pipes, connections may be made with the vacuum suction, so that accumulations are readily removed. The amount of arsenious acid removed is from 1½ to 2 tons per hour. The power absorbed by the vacuum pump is from 12 to 14 hp. It has been found that by means of this plant no noxious fume escapes into the atmosphere, and that the operators are not exposed to poison.

Horse versus Compressed Air Haulage.—The June *Bulletin* of the Canadian Mining Institute contains a paper by Raoul Green giving comparative costs of haulage underground at coal mines in Alberta using horses and compressed-air locomotives respectively. The ordinary working conditions are used for comparison, the author holding that figures for the theoretical but impossible maximum amount of work are valueless to the engineer. The figures for compressed-air haulage were taken for a month's work, during which 19·5 haulage shifts were worked. The coal hauled underground was 33,826 tons, and the ton-miles 70,260. The month's expenses were: Labour \$3360, coal and other supplies \$1238, depreciation of plant costing \$114,445, \$1048; total \$5646. These figures are equivalent to 7·8 cents per ton-mile, consisting of labour 4·6 cents, coal and supplies 1·7 cents, and depreciation 1·5 cents. In the case of horse haulage, the coal hauled was 15,573 tons and the days worked 25. The ton-miles were 14,450. The labour cost was \$1048, supplies for 22 horses \$330, depreciation on value of horses (averaged over 5 years) \$48, depreciation on equipment costing \$17,266, \$167, total depreciation \$215; total monthly expenses \$1593. The cost per ton-mile was 10·9 cents, made up of 7·2 cents for labour, 2·2 cents for supplies, and 1·5 cents for depreciation. It will be seen that the depreciation was the same with both horses and compressed air, the cost of supplies rather greater with the horses, and the cost of labour much greater with the horses. The total cost per ton-mile was 7·8 cents with compressed air and with horses 10·9 cents, the advantage being 3 cents on the side of the compressed air.

Origin of Topaz and Cassiterite.—In the *Geological Magazine* for June, William R. Jones discusses the origin of topaz and cassiterite in the Gunong Bakau tin lodes, Federated Malay States. In particular he traverses J. B. Scrivenor's theory that they are primary minerals and the topaz not an alteration-product due to the action of fluorine-bearing vapours on felspar. Dr. Jones argues that the evidence is in the other direction, and that they are alteration-products. He is of opinion that the mode of occurrence of the topaz and cassiterite is similar to that in the Erzgebirge, where the two minerals are generally held to be alteration-products.

TECHNICAL JOURNALS FOR THE MONTH

BRITISH.

Colliery Guardian.—*June 2:* The National Value of Coal and Coal Shipping, F. J. Warden-Stevens. *June 9:* Coal Handling Equipments of the Great American Lakes, F. J. Warden-Stevens. *June 23:* Pit-head Baths at Treharris Collieries, South Wales. *June 30:* Coal Shipping from South Africa, F. J. Warden-Stevens.

The Engineer.—*June 16:* Trade Terms used in the Iron and Steel Trades of Great Britain. *June 23:* Proposed Inland Waterways to connect the Danube and Rhine, and the Elbe and Weser; Trade Terms used in the Coal Markets of Great Britain.

Engineering.—*June 23:* Burner for Simultaneous Gas and Coal Firing for Steam Boilers.

Institution of Mining Engineers.—*June 8:* Health of Old Colliers, J. S. Haldane; Absorption of Oxygen by Coal, Estimation of Moisture in Coal, Atmospheric Oxidation of Pyrite, T. F. Winmill; History of the Safety Lamp, T. W. Hardwick and L. T. O'Shea.

Institution of Mining and Metallurgy Bulletin.—*June:* The Conglomerates of the Witwatersrand, discussion on Dr. Mellor's Paper, T. A. Rickard.

Iron and Coal Trades Review.—*June 16:* Silica and Fireclay Materials, John West, from a paper read before the Manchester District Institution of Gas Engineers. *June 23:* Taking Curves with Overhead Haulage, T. A. Hair and J. Bowman; Steel Props at Tinsley Park Colliery. *June 30:* Production and Use of Power and its Relation to Fuel Economy, G. Stanley Cooper; Pumping Plant at Glencraig Colliery, Fife.

National Association of Colliery Managers, North of England Branch.—*May 20:* Economies in Lubrication at Edmondsley Colliery. Midland Branch, *June 10:* Mine Air Analysis, W. H. McMillan.

Manchester Geological and Mining Society.—*June 20:* Shaft-sinking by the Freezing Process, F. Schmidt.

The Mining Journal.—*June 24:* The Ardlethan Tinfield, Australia; The Copper Industry of British Columbia, R. C. Campbell Johnstone; St. John Mines, Colorado.

Colonial.

Australasian Institute of Mining Engineers.—*Proceedings No. 21, 1916:* The Chemical Assay of Tin Ores, A. M. Matheson; Organization and Equipment of a Mine Rescue Station, J. C. Coldham; Sheelite-Gold Mines of Otago, New Zealand, C. W. Gudgeon.

Canadian Mining Institute Journal.—*June:* Costs at Porcupine and other Canadian Mines; Recent Improvements in Concentration at the Washoe Works, Anaconda, E. P. Mathewson; Costs of Horse and Compressed-Air Haulage Underground, R. Green.

Canadian Mining Journal.—*May 15:* Renewed Activity at Cobalt; University Needs of the Maritime Provinces, F. W. Gray; Metallurgical Improvements in British Columbia, E. Jacobs. *June 1:* Placer Mining in British Columbia, E. Jacobs. *June 15*; The Silver Deposits of Cobalt, Ontario, a short history of the output; Concentration of Cobalt Silver Ores by Flotation Processes, A. A. Cole; Recent Developments in the Cobalt District.

Chemical, Metallurgical, and Mining Society of South Africa Journal.—*April:* Concrete Shaft Equipment at the Bantjes Mine, W. W. Lawrie and G. Hildick Smith.

Mining and Engineering Review (Melbourne).—*May:* Selling Lead and Zinc Concentrates, Wilton Shellshear.

South African Institution of Engineers Journal.—*May:* The Johannesburg Municipal Electric Power Station, J. H. Dobson.

South African Mining Journal.—*April 29:* Ore Reserves of the Rand; Salaries and Wages in Transvaal Mines during 1915; Rand Earth Tremors Committee's Report [continued May 6]. *May 13:* Miners' Phthisis Compensation; The War and South African Trade; Medical Examination for Mine Workers, Samuel Evans. *May 20:* Phthisis Compensation Reform; How the Mines are Fighting Miners' Phthisis.

Foreign.

American Institute of Mining Engineers Bulletin.—*June:* Coal and Oil Resources of the Turkish Empire, L. Dominian; Stoping Methods at the Miami Copper Co.'s Mine, D. B. Scott; Flowing Temperatures of Copper Mattes and Copper-Nickel Mattes, G. A. Guess and F. E. Lathe; Determination of Dust Losses at the Copper Queen Reduction Works, J. M. Samuel.

Economic Geology.—*March-April:* Genesis of Chilean Nitrate Deposits, J. T. Singewald and B. Leroy Miller; Oxidation of Manganese Solutions in Presence of Air, V. Lenher; Sericite a Low Temperature Hydrothermal Mineral, A. F. Rogers; Metallographic Study of the Copper Ores of Maryland, R. M. Overbeck. *April-May:* Conservation of Oil and Gas Resources of the Americas, Ralph Arnold; Garnet Deposits in Navajo Reserve, Utah-Arizona, H. E. Gregory; Ore Genesis and Contact Metamorphism at Long Lake Zinc Mine, Ontario, W. L. Uglow; Occurrence of Petroleum in the Philippines, W. E. Pratt; Pitchblende Deposits of Gilpin County, Colorado; Occurrence of Older Beds in Structural Depressions, Dorsey Hager.

Engineering and Mining Journal.—*May 27:* Tin Smelting at Perth Amboy, R. H. Vail; Valuation of Oil Properties, Dorsey Hager; Samples and their Interpretation, E. H. Dickenson and H. J. Volker. *June 3:* Churn-Drill Prospecting at Morenci, Arizona, W. R. Grunow; Manufacture of Cartridge Brass, C. R. Barton; Control of Ore Slimes—III, O. C. Ralston. *June 10:* The Cerro de Pasco District, Peru, J. T. Singewald and B. Leroy Miller; Portable Mining Equipment for Prospects, L. A. and W. C. Rehfuss. *June 17:* Lübecker Excavator in the Yukon, C. A. Thomas; Dust Allaying in Rand Mines, A. Cooper Key; Properties of Slime Cakes, E. E. Free [continued June 24]; New Buildings of the Massachusetts Institute of Technology and Harvard University. *June 24:* Drill and Tool Sharpening Shop at the Copper Queen Mine.

Iron Age.—*May 25:* The Steel Industry of Belgium, H. H. Campbell; Utilizing Powdered Coal in the Open-Hearth Furnace. *June 1:* Distribution of Raw Materials in the Blast-Furnace, G. W. Vreeland. *June 8:* Vacuum-melted Pure Iron; Economical Use of Blast-Furnace Gas, A. N. Diehl. *June 15:* Measuring the Capacity of Air-Compressors, P. Diserens; A Blast-Furnace Built in 85 Days.

Metallurgical and Chemical Engineering.—*June 1:* The Roitzheim-Zinc Distillation Furnace, M. Liebig; Ore Flotation, Wilder D. Bancroft; Distribution of Silver between Metallic Lead and Litharge-containing Slags, Boyd Dudley [continued June 15]; Distribution of the Charge Column and of the Ascending Gas Column in Blast-Furnaces, J. E. Johnson; Extraction of Petrol from Natural Gas by Absorption Methods, G. A. Burrell, P. M. Beddison, and G. G. Oberfell; Cost Accounting in the Construction and Operation of a Copper Smelter, E. E. Thum. *June 15:* Flotation and Cyanidation, G. H. Clevenger, E. A. Hersam, J. A. Pearce; Arc Furnace for Laboratory Use, O. P. Watts; The Sherardizing Process, O. W. Storey; Coke as a Reducing Agent in the Electric Smelting Furnace, R. C. Gosrow; Extraction of Gold and Silver from Matte by Lead, W. Mostowitsch; Flotation Oils, O. C. Ralston; A New Dry Amalgamator, L. A. Palmer.

Mining and Engineering World (Chicago).—*May 20:* Mining Possibilities in Colombia (continued in issue of June 10), M. W. Alderson; Breaking-down Froth in Callow Flotation Cell; Direct Drive for Flotation Machines at Utah Copper, G. B. Rosenblatt. *May 27:* Rice Lake District, Manitoba, W. K. Harding; Dry Placer Mining, Yuma County, Arizona, W. G. Keiser. *June 3:* Flotation Process at Goldfield, Nevada. *June 17:* Flotation at the Standard Silver-Lead Mine, using Wyman Cell, British Columbia, J. G. Parmelee; Concrete Foundations for Mining Plant, Algernon Del Mar.

Mining and Scientific Press.—*May 20:* Effect of Black Slate on Cyaniding, H. H. Fischer; New Bag-House at the Midvale Smelter, L. S. Austin; Stoping by Branched Rises, F. W. Sperr. *May 27:* Nitrogen Gas in a Mine, W. J. Sharwood; Dry Chlorination Tests on the Malm-Ashcroft-Swinburne Principle at Bunker Hill; Tungsten District of Boulder County, Colorado; Tungsten Mines of Atolia, California, C. T. Hutchinson; Concentration of Quicksilver Ores. *June 3*: Surficial Indications of Copper—II., F. H. Probert [continued June 17]; International Smelting Company's Miami Plant, L. R. Wallace; Tungsten Mining in Arizona, C. F. Willis; Alkalinity of Cyanide Solutions, A. M. Smith. *June 10:* A History of the Discovery of the Cyanide Process, John S. MacArthur; Flotation Oils, O. C. Ralston. *June 17:* Gold Mining in the Philippines, C. M. Eye; Ozokerite in Utah, L. O. Howard.

NEW BOOKS AND OTHER PUBLICATIONS

Industrial Gases, including the Liquifaction of Gases. By Geoffrey Martin, E. A. Dancaster, J. M. Dickson, F. B. Gatehouse, E. Jobling, and H. S. Redgrove. Cloth, octavo, 150 pages, with many illustrations. London: Crosby Lockwood & Son. Price 7s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is another of that excellent series of manuals of chemical technology issued by Crosby Lockwood under the general editorship of Dr. Geoffrey Martin. Previous volumes have been devoted to sulphuric acid, nitrogen compounds, chlorine, salt and alkali, rare earths, and coal-tar products. The present volume deals with the production of gases used for industrial purposes, namely oxygen, hydrogen, nitrogen, carbon dioxide, sulphur dioxide, ammonia, acetylene, producer and illuminating gas, and ozone. During the past few years the production and uses of the first seven mentioned have expanded to an extent not appreciated by the average engineer, and it is the part of the book describing these that is of special value. As we mentioned in our May issue, hydrogen has assumed a great commercial importance recently. Synthetic ammonia has also 'arrived.' Nitrogen in pure gaseous state is used on a large scale in the manufacture of cyanamide, and its application in other directions may be expected. The opportunity of producing oxygen and nitrogen on a large scale was first provided by Linde and Claude, whose systems of fractional separation of the constituents of air by means of liquifaction were introduced a dozen years ago. The book therefore starts appropriately with a chapter on the liquifaction of gases. Subsequently the gases, their uses, and manufacture are described individually in the various chapters. The book is one that may be thoroughly recommended. In a future edition we hope the authors will give us some notes on the production of sulphuretted hydrogen on a commercial scale.

Canadian Mining Manual. Edited by Reginald E. Hore. Cloth, quarto, 440 pages, illustrated. Toronto: *The Canadian Mining Journal*. Price 12s. 6d. For sale at the Technical Bookshop of *The Mining Magazine*.

The Canadian Mining Manual was founded by the late B. T. A. Bell, the secretary of the Canadian Mining Institute, and it is now produced by Mr. Hore, the editor of the *Canadian Mining Journal*. This volume begins with a general review of the mineral output for 1915, and then the production of each metal and mineral is examined in detail. This part occupies about 200 pages. Another 200 pages is devoted to the various mining companies, giving particulars of their organization and the properties worked, the system adopted being that of the 'Copper Handbook' rather than that of Skinner's 'Mining Manual.' A final section contains a list of mining companies, indexed according to the minerals or metals handled.

Details of Practical Mining. Compiled from the pages of the *Engineering and Mining Journal*. Cloth, octavo, 544 pages, 440 illustrations. New York: McGraw-Hill Book Co. Price 21s. For sale at the Technical Bookshop of *The Mining Magazine*.

This book is on similar lines to the 'Handbook of Mining Details,' and 'Handbook Milling Details,' consisting of reprints of articles and notes that have appeared in the *Engineering and Mining Journal*. It is of value as a miner's collection of cuttings.

The Data of Geochemistry. By F. W. Clarke. This is the third edition of a valuable book of reference, often quoted by economic geologists, and it constitutes Bulletin 616 of the United States Geological Survey. It collects chemical evidence bearing on the origin and alterations of mineral deposits, and on the mode of occurrence and associations of the various minerals.

Tin-Mining Handbook, 1916. This is third issue of a handbook published by *The Financial Times*. The present edition is compiled by A. N. Jackman. It gives details of all the companies engaged in tin-mining in various parts of the world. The price is 2s. 6d. net.

Rubber Producing Companies. This book is compiled by the Mincing Lane Tea & Rubber Share Brokers' Association, and is published by *The Financial Times*. The price is 3s. net.

Extraction of Radium, Uranium, and Vanadium from Carnotite. This is a bulletin of the United States Bureau of Mines prepared by C. L. Parsons, R. B. Moore, S. C. Lind, and O. C. Shaefer, and describes in detail the work done by the Bureau and the National Radium Institute.

Manufacture of Gasoline and Benzene-Toluene from Petroleum and other Hydrocarbons. We have just received Bulletin 114 of the United States Bureau of Mines describing the researches of W. F. Rittman, C. B. Dutton, and E. W. Dean into the cracking under heat and pressure of petroleum with the object of producing according to conditions either petrol or benzene and toluene. We gave an outline of this process in our issue of April.

Some Engineering Problems of the Panama Canal in their relation to Geology and Topography. This is Bulletin 86 of the United States Bureau of Mines, and is written by Donald F. MacDonald. It gives a geological account of the rocks through which the canal cuts have been made, and thereby explains the difficulties now caused by landslides which block the canal. In England civil engineers have been in the habit of seeking geological advice before embarking on enterprises of this sort. American engineers, not having had previous experience of tropical conditions, were not acquainted with what J. H. Goodchild calls 'digested' igneous rocks, hence their trustfulness with regard to the sides of the Culebra cut. Mr. MacDonald's studies should help to give the canal problem its right complexion.

We have received the following new books, reviews of which will appear in later issues:

Centrifugal Pumps and Suction Dredgers. By E. W. Sargeant; published by Charles Griffin & Co., Ltd. Price 10s. 6d. net.

Text-Book of Practical Hydraulics. By James Park; published by Charles Griffin & Co., Ltd. Price 12s. 6d. net. A book for the mining engineer in search of a water supply for an alluvial property.

The Metallurgy of Steel. By F. W. Harbord and J. W. Hall. Fifth Edition; published by Charles Griffin & Co., Ltd. Price 36s. net.

Mechanical Engineers' Handbook. By L. S. Marks; published by the McGraw-Hill Book Co. Price 21s. net.

Metallurgists' and Chemists' Handbook. By D. M. Liddell; published by the McGraw-Hill Book Co. Price 17s. net.

Coal Miners' Pocketbook. Published by the McGraw-Hill Book Co. Price 17s. net.

YEARLY REPORTS OF MINING COMPANIES

Burma Corporation.—This company was formed in 1913 to acquire the share capital and the majority of the debentures of Burma Mines, Limited. H. C. Hoover has been chairman until recently, but resigned owing to his time being occupied with the American Commissions for Relief in Belgium and Poland. The technical committee consists of T. J. Hoover, R. Gilman Brown, E. Heberlein, and A. F. Kuehn, and Bewick, Moreing & Co. are the consulting engineers. We gave lengthy accounts of the property owned, the Bawdwin lead-zinc-silver mines, in our issues of May and June 1914, January 1915, and March 1916. The Burma Mines company was originally formed in 1904 to acquire old mines containing oxidized silver-lead ores, and also old slag heaps, at Lashio in the Northern Shan States, Burma. More recently attention has been devoted to the development of the orebody in the sulphide zone. This work has been done from the Chinaman adit, from which have been sunk an internal shaft and a main winze. To tap the deposit at depth, the Tiger adit is being driven to intersect the ore at 653 ft., or 500 ft. below the Chinaman adit. The original policy of the company was to sell lead ore and concentrate and mixed sulphides to German buyers, but since the war the programme has been altered, and experiments are being conducted with concentration plant with the object of producing lead and zinc concentrates and ultimately smelting them. While the treatment question is being settled, picked ore high in lead and old lead slag are being smelted and the silver-lead bullion refined. The report for the year 1915 shows that 10,453 tons of lead ore averaging 37 to 45% lead, and 32,091 tons of old slag averaging 40% lead were delivered to the smelter. The amount smelted, ore and slag mixed, was 36,628 tons, and the yield 13,976 tons of bullion, containing from 17 to 36 oz. silver per ton. Of this bullion, 7123 tons was shipped to London for refining and sale, and the remainder refined on the spot. As regards mining operations, the three top levels have been fully developed, and four other levels have been opened. The Tiger adit was driven for a distance of 2979 ft., making the total length of 3744 ft., and leaving 3506 ft. still to be driven. A drift from the bottom level at 653 ft. is now being driven to meet the adit; and the work will, it is expected, be completed in October. The ore reserve has been increased by a million tons during the year, and is estimated at 2,300,000 tons averaging 27·5% lead, 22·2% zinc, and 25·4 oz. silver per ton. Indications point to the orebody continuing in size and value on the two bottom levels, and it is anticipated that an additional 733,000 tons will be disclosed when the levels are further developed. K. A. Mickle is conducting experimental work in connection with concentration, and his results await confirmation on a larger scale of operations. He has obtained a lead concentrate comprising 39% of the ore, assaying 55% lead, 14% zinc, and 45 oz. silver; and a zinc concentrate comprising 35% of the ore, averaging 45% zinc, 10% lead, and 15 oz. silver per ton.

Guiana Gold.—This company was formed in London in 1905 for the purpose of acquiring the St. Mary's alluvial concessions in British Guiana from the British Guiana Exploration Syndicate which was formed in 1903. Four dredges are at work over 20 miles of river. Dividends have been paid regularly since 1908, the total to date being 92½% on a capital of £50,000. The report for the year ended March 31 shows that the gold recovered was equal to 8573 oz. fine, selling for £32,992. The working cost was £22,849, administration expenses and taxes £1708, allowance for depreciation £2824, royalty £1349. The sum of £5000 was distributed as dividend, being at the rate of 10%.

Geevor Tin Mines.—This company was formed, as the North Levant and Geevor, by Oliver Wethered in 1906 to develop tin mines adjacent to the Levant and Botallack, near St. Just, West Cornwall. Additional capital was raised in 1909 and 1911, on the latter occasion the name being changed, and since then further money has been borrowed on loan. The issued share capital is £50,000, issued debentures £16,110, and loan £9729. Three years or so ago modern tables and re-grinding plant were tried, but as results did not come quick and in the meantime the finances became critical, it was decided to revert to ordinary Cornish practice. The report for the year ended September 30, 1915, shows that 25,487 tons of ore was raised and treated, and 353 tons of concentrate extracted, being a yield of 31·9 lb. per ton. The amount realized was £30,100, and the working profit was £4358. Interest on loan absorbed £2548, and £1256 was written off. It has not been possible to pay the debenture interest, and arrangements are being made to fund some part of the amount due. Since the yearly report was issued, the developments at depth have been excellent, and we refer to the subject in our Review of Mining.

Siamese Tin Syndicate.—This company was formed in London in 1906 to work alluvial tin deposits at Ngow, in the Renong district of the Western Siamese States. Cyril K. Butler is chairman, and H. G. Scott is manager. The first dredge was started in 1912, the second in 1914, and the third in January 1915. For convenience in accounting, the termination of the company's year has been altered from September 30 to December 31, so that the present report covers nine months instead of a year. The report for the nine months ended December 31, 1915, shows that the three dredges treated 1,275,200 cubic yards, for an output of 724 tons of tin concentrate. The yield per yard was 1·27 lb. of black tin. The income per yard, after the deduction of government royalty, was 12·8d., and the working cost per yard was 6·2d. The accounts show receipts from the sale of concentrate of £78,136, and a net profit, after allowance for depreciation, of £20,633. Adding £7574 brought forward from the previous year, the disposable balance was £28,207. Out of this, £24,000 has been distributed as dividend, being at the rate of 20%.

Lahat Mines.—This company was formed in 1906 for the purpose of acquiring a tin-gravel property at Lahat, in the Kinta Valley, Perak, Federated Malay States. The promoters were E. C. Edgar and Foo Choo Choon, who are well known as the vendors of the Tronoh property. The Lahat and Tronoh companies have continuously had the same London office. The output of tin concentrate in 1909 was 595 tons. Since then the output gradually decreased, and the dividends, which started in 1909, disappeared in 1914. The report for the year 1915 shows that on the resignation of the manager, O. S. Dawbarn, in August, Osborne & Chappel were appointed general managers. The new engineers have extended the development plans, and have made arrangements for an increase in power-supply. During the year, 264 tons of concentrate was sold realizing £25,522, and the accounts showed a loss of £2583. Since the beginning of 1916, the conditions have improved, and from January to

May the output of concentrate was 190 tons.

Kramat Pulai.—This company was formed in 1907 to acquire alluvial tin property at Pulai, in the Kinta district of Perak, Federated Malay States. The capital is £100,000, and dividends averaging 10% have been paid since 1912. Nutter & Pearse are the managers, and F. W. Payne & Co. are the consulting engineers. The report for the year 1915 shows that 613,450 cu. yd. of gravel was treated, for a yield of 293 tons of tin concentrate. The accounts show receipts of £25,862 from the sale of the concentrate and £1509 from tributers. The net profit was £13,338, out of which £10,000 was distributed as dividend, being at the rate of 10%.

Rayfield (Nigeria) Tin Fields.—This company was formed by Oliver Wethered, under the name of the Rayfield Syndicate, in 1910 to acquire prospecting rights in Northern Nigeria. A large number of properties were inspected and tested by the first manager, B. H. Nicolson. The original capital was £10,000, which was afterwards increased to £20,000. In 1912 the company was reconstructed on a larger scale, under the present name, and the capital was expanded to £400,007. Dividends amounting to £40,000 were paid for the year ended September 30, 1913, but immediately afterward the company was faced with financial troubles, and it became necessary to issue £50,000 debentures. The present properties are the Top, Shen, Lower Shen, and Delimi. The report for the year ended September 30 shows that 346 tons of concentrate was won from the Top property, 168 tons from the Shen, 80 tons from the Lower Shen, and 35 tons from the Delimi. The accounts show a revenue from the sale of concentrate of £63,993, and a net profit of £4514. After deducting the adverse balance from the previous year, a credit balance was left of £1686. J. M. Iles, the manager, has conducted extensive boring tests on the Delimi property. He is returning to England, and will discuss with the directors a revised plan for dealing with the Delimi and the other properties.

Ex-Lands Nigeria.—This company was formed in 1912 by the Exploring Land & Minerals Co. (a company previously identified with Rhodesia) for the purpose of acquiring alluvial tin properties in the South Bukeru district, Bauchi Province, Northern Nigeria. The report for the year 1915 shows that 388 tons of tin concentrate was produced. The accounts show credits of £38,894 and a net profit of £17,952. The year began with a debit balance of £2537, so that the available balance was £15,415. A dividend of £10,117 or 7½% free of income tax was paid. Since the end of the year 2½% has been paid as an interim dividend for the current year.

Kaduna Syndicate.—This company was formed in 1910 to acquire alluvial-tin properties in Northern Nigeria. The first properties investigated were in the Kano district, but subsequently properties in the Arim district, 16 miles southwest of Bukeru, were acquired. Production started in 1912. The yearly report now issued covers the period ended October 31 last. During the year 216 tons of concentrate was extracted and 218 tons was sold, realizing £21,542. The working profit was £8371, out of which £3513 was distributed as dividend, being at the rate of 35%. The capital issued is £10,040, and there are £8880 debentures. Lake & Currie are the consulting engineers, and J. E. Snelus is manager.

Bisichi Tin (Nigeria.)—This company was formed in 1910 to acquire alluvial-tin ground in the Bisichi River area, Northern Nigeria, and hydraulicking began in April 1912. The company also owns interests in the Lafon River Tin Areas and the Zuma Tin Areas. Laws, Rumbold & Co. are the managers. The report for the year 1915 shows that 310 tons of concentrate was won, as compared with 255 tons in 1914 and 370 tons in 1913. The accounts show credits of £32,161, and a net profit of £10,078. A dividend at the rate of 5% has been paid on the capital of £200,000.

Zinc Corporation.—This company was formed by Bewick, Moreing & Co. in 1905, when H. C. Hoover was a partner in the firm, for the purpose of applying the flotation process to dumps of zinc tailing at Broken Hill. The first process tried was that of Minerals Separation, but in those early days the results were not good. The Elmore vacuum process was then tried, and it ran profitably for two years or so; but it had to give way to the improved Mineral Separation process in 1910. In 1911 the Broken Hill South Blocks mine was acquired, and in 1914 an interest in Barrier South company, formerly the South Extended, was purchased. The corporation was thus turned into a lead-zinc mining company instead of merely a treater of dumps. F. A. Govett and T. J. Hoover are the managing directors. The sale contract for the lead and zinc concentrates was with Aron Hirsch und Sohn, and has been recently cancelled by government action on terms detailed in our last issue. The report for the year 1915 shows that the lead concentrator ran for 247 days and treated 154,628 tons of ore averaging 14·4% lead, 9·1% zinc, and 2·6 oz. silver. The yield of lead concentrate was 31,307 tons averaging 61·1% lead, 7·4% zinc, and 9·1 oz. silver, and 33,975 tons of zinc middling was produced assaying 16·9% zinc, 4·3% lead, and 1·4 oz. silver. The lead concentrate was delivered to the Broken Hill Associated Smelters. The zinc concentration plant was idle all the year, but in January 1916 it was re-started on the arrangement of a contract with Japanese buyers for the sale of 17,500 tons of zinc concentrate before March 1917. This contract only keeps the plant partly occupied. No further move in connection with the production of zinc concentrate will be made until the Commonwealth Government settles its future policy relating to metals. The accounts for the year show receipts of £320,340 and working expenses £157,218. After allowance for administration, taxes, and depreciation, the net profit for the year was £115,529. Out of this, £49,138 was distributed as the cumulative 20% dividend on the preference shares, and it is proposed to pay £44,941 as a dividend of 1s. on both preference (245,692, £1 each) and ordinary (653,139, 10s. each) shares. The undivided profit brought forward from 1914 has been devoted to subscribing for £100,000 shares in the Broken Hill Associated Smelters. The company is creditor against Aron Hirsch und Sohn to the extent of £84,687 for zinc concentrate delivered before the outbreak of war. Development now in hand has for its object the opening of the western orebody to the southwest of the main lode, and nearer the parallel zinc lode farther west. For this purpose the sinking of No. 5 shaft is being continued and it is to go down to the same level, No. 10, as the main shaft. This work will have the additional advantage of providing the necessary ventilation of the lower levels, which are becoming uncomfortably hot. The ore reserve is estimated at 1,504,211 tons averaging 14·8% lead, 9·2% zinc, and 2·5 oz. silver, an increase of 318,341 tons during the year. It is not expected that current development will add to this reserve, for most of it will consist of driving levels, sinking, and rising for the purpose of opening the ground between the two shafts.

Amalgamated Zinc (De Bavay's).—This company was formed in 1909 in Australia to acquire the business of the De Bavay's Treatment Company, and to expand the scale of operations. The company owns the De Bavay flotation patents, and treats zinc tailing produced at the North and South mines at Broken Hill. The company has also treated zinc tailing from Block 10 mine, but this mine was closed after the outbreak of the war. The report for the half-year ended December 31 last shows that the plant treated 161,043 tons for a yield of 48,195 tons of zinc concentrate and 710 tons of lead concentrate. The whole of the zinc concentrate has been sold to American buyers. H. W. Gepp, the general manager, has been in America for some time in connection with these contracts, and he has taken the opportunity of studying the experiments in electro-deposition of zinc from its ores now in progress there. W. L. Baillieu, the chairman, has been in negotiation with the hydro-electric department of the Tasmanian Government with a view to securing current at a sufficiently low price to warrant the application of this method of treatment to the company's concentrate. The accounts show a profit of £168,078, out of which £75,000 has been distributed as dividend, being at the rate of 3s. per £1 share.

Great Boulder Proprietary.—This company was floated in London by G. P. Doolette (now Sir George) and his friends in the year 1894, for the purpose of acquiring gold-mining claims at Kalgoorlie, West Australia. The development was done by Zebina Lane, who had been previously manager of Broken Hill Block 14, and for a short time John Taylor & Sons were the consulting engineers. Since 1896 the management of the mine has been in the hands of Richard Hamilton. The output and dividends have been large and remarkably regular. Production commenced in April 1895, and divisible profits were made from the beginning. The total yield of gold to the end of 1915 has been £10,124,194, of which £4,869,375 has been distributed as dividends. For the last eleven years the dividend has remained unaltered at £262,500, or 150% on the capital. About four years ago, however, the orebody began to show impoverishment at depth and little or no ore has been found below the 2500 ft. level. Nor has lateral exploration by diamond-drill disclosed anything but isolated lenses. The report for the year 1915 shows that 195,524 long tons of ore averaging 13·85 dwt. per ton was raised and treated for a yield of gold worth £583,366. The working profit was £314,933, out of which £15,454 was paid as taxes, £10,000 placed to exploration account, £25,000 placed to reserve fund, and £262,500 distributed as dividend. During the year the development of the mine added 129,441 tons to the reserve, which now stands at 494,564 tons averaging 14·36 dwt. per ton, as compared with 560,647 tons averaging 14·85 dwt. at the end of 1914. In many of the levels the orebody proves to be 2 ft. wider than expected, so that the ultimate reserve is increased. In looking through Mr. Hamilton's table of reserves in the levels from 300 ft. to 2500 ft., it is interesting to note that on the 500 ft. level there remains a length of back of 178 ft., 7½ ft. wide, and assaying 41 dwt. per ton, and that ore on the 700 ft., 800 ft., 900 ft., and 1100 ft. levels averages from 20 to 35 dwt. In the lower levels the ore averages from 7 to 13 dwt. per ton.

Great Boulder Perseverance.—This company was formed in 1895 to acquire property at Kalgoorlie, West Australia. In those days F. L. Gardner was chairman, and Zebina Lane was manager, and large profits were made from high-grade ore. The sudden collapse of the company in 1904, during the management of Ralph Nichols, owing to the shareholders not having been warned of the approaching exhaustion of the high-grade ore, was one of the unpleasant incidents of Kalgoorlie mining. After this collapse, Hooper, Speak & Co. were appointed consulting engineers. The ore treated during the last dozen years has been of low grade, and the distributable profits have been small. The report for the year 1915 shows that the amount of ore sent to the mill was much the same as in previous years, the figure being 239,314 tons, from which gold worth £247,275 was extracted. The net profit for the year was £3201. Owing to the increase in costs, the advisability of continuing operations has become a debatable point. It was found, in any event, desirable to stop development work. The ore reserve at the end of December was estimated at 544,474 tons averaging 22s. per ton, of which 268,174 tons averaging 21s. 5d. was broken ore, and 276,300 tons averaging 22s. 9d. was ore ready for stoping. In addition there was 317,480 tons partly blocked out averaging 21s. per ton. The proposal is to treat the broken ore and to mine the best portions of the ore in place, and then discontinue operations.

Lake View & Star.—This company was formed in 1910 to acquire the Lake View Consols and Hannan's Star gold mines at Kalgoorlie, West Australia. The Lake View was previously one of the great mines of the district, but the rich ore had been exhausted, and Hannan's Star had only been indifferently successful. The formation of the company was coincident with that of the Lake View & Oroya Exploration, the object of the latter being to continue the financing and development of many mining ventures in various parts of the world. F. A. Govett is chairman of the company, James Brothers are the consulting engineers, Bewick, Moreing & Co. are the general managers, and H. E. Vail is mine superintendent. Dividends have been paid regularly since 1912. The report for the year ended February 29 last shows that the output of gold has decreased owing to a fall in the grade of the ore at both of the mines. At the Lake View, 94,581 tons of ore was raised, and at Hannan's Star 101,151 tons, being a total of 195,732 tons, averaging 25s. 3d. per ton. The gold extracted was worth £216,618, or 21s. 9d. per ton. The working cost was £199,110, or 20s. 4d. per ton. In addition, £2516 was paid as London expenses, £500 as directors' percentage, and £1500 as West Australian government duty. By transferring £10,000 from the reserve fund, it has been possible to distribute £30,000 as dividend, being at the rate of 15% for the year. The development has been restricted owing to the scarcity of competent labour, so many of the best men having gone to the war. The reserve at Lake View was estimated on February 29 at 79,357 tons, the average gold content being 27s. 10d. per ton, and at Hannan's Star 274,170 tons averaging 25s. per ton. As compared with the figures the year before, Lake View reserves show a fall of 22,223 tons and those at Hannan's Star a fall of 50,551 tons. The content of the reserve at Lake View was much the same as the year before, but at Hannan's Star it was 1s. 6d. less. Stoping on the 2100 ft. level, the lowest, at Lake View has given poor results lately, and at Hannan's Star no new ore has been discovered. During the year the Chaffers mine was purchased, but as its lowest levels are filled with water, no adequate examination of the workings has been possible as yet.

Bullfinch Proprietary.—This company was formed in 1910 by G. P. Doolette (now Sir George) and his friends to acquire gold mining claims 23 miles south of Southern Cross, West Australia. The purchase price was £100,000 in cash and £300,000 in shares. Milling commenced in February 1913. The report for the year 1915 shows that 76,886 tons of ore was raised and treated, for a yield of gold worth £100,035, equal to 26s. per ton. The net profit, after allowance for depreciation, taxes, etc., was £16,313. Adding the balance brought forward from the previous year, £14,978, the disposable balance of profit was £31,291. Out of this, £23,807 was paid as dividend, being at the rate of 5%. A. L. Hay, the manager, reports that the sinking of the main shaft has been continued, and that levels have been opened at 410 ft. and 510 ft. The reserve at December 31 was estimated at 97,334 tons averaging 25s. 5d. per ton. During 1913 the yield per ton was 54s. 7d., and in 1914 it was 29s. 5d. The dividends for 1913, 1914, and 1915 were 5%, 11¼%, and 5% respectively.

Wallaroo & Moonta.—This company has its headquarters at Adelaide and was formed 26 years ago to work two copper mines in South Australia on the eastern side of Spencer gulf. The report for 1915 shows that operations at depth in the Wallaroo mine continue to give excellent results, and that at the 2790 ft. level the orebody is developing satisfactorily. Owing to the rise in the price of copper, it has been possible to mine ore of lower grade than during the preceding years, and to re-treat old dump material. At the Moonta mine, the ore in the main lode is exhausted, but other lodes continue to be productive. The amount of ore raised at the Wallaroo during the year was 136,791 tons, and 61,960 tons was taken from the dumps. The total sent to the picking and concentration plant was 211,665 tons averaging 3·03% copper. The ore and concentrate obtained was 58,551 tons averaging 9·6% copper. At the Moonta mine 38,798 tons averaging 3·5% copper was raised, and 7994 tons of concentrate averaging 16·8% copper was obtained. At the smelting works 65,742 tons of ore was smelted and refined, together with 1025 tons of precipitate produced at Moonta. The output of the refinery was 7653 tons of copper and 3027 oz. gold. The accounts showed a profit of £163,321, and £60,000 was distributed as dividend, being at the rate of 18¾%. The company used to market the copper through Aron Hirsch und Sohn, but now sells almost entirely to munition makers in England. An arrangement has been made with the Commonwealth Government whereby the company will smelt and refine ore and concentrate from Queensland, and the works are being extended accordingly.

Buena Tierra.—This company was formed by the Exploration Co. in 1912 for the purpose of purchasing a group of silver-lead properties, previously worked by local owners, in the Santa Eulalia district, Chihuahua, Mexico. The ore is lead carbonate, with some silver, with a considerable iron content, and it is sold to the Chihuahua smelter of the American Smelting & Refining Co. The property was purchased on the reports of R. T. Bayliss and R. M. Raymond. The capital is £330,000. Dividends of 5% were paid for 1912, and 1914. The local political turmoil has greatly interfered with operations. The report for the year 1915 shows that work was continued intermittently from January to September, that for the remainder of the year operations were suspended, and that on January 18 the staff had to leave. During the year, 18,525 tons of ore was raised, and after the rejection of rock and low-grade material, 16,993 tons was sent to the smelter, averaging 13·4% lead and 11¼ oz. silver. The income from the sale of ore was £30,294, and the net profit was £5308, which was carried forward. A. C. Brinker, the manager, reports that no new orebodies were discovered during the year, though the indications are favourable at several points. The reserve at the end of the year was 281,500 tons, compared with 300,000 tons the year before.

Esperanza.—This company was formed in London in 1903 to acquire most of the shares of the Esperanza Mining Co., a New Jersey corporation operating the Esperanza gold mine at El Oro, Mexico, situated between the El Oro and Mexico mines. Handsome profits were made for eight years, and since then the developments have given poor results. For some time the operations have been confined to reclaiming filling and to working the low-grade ore left behind in the upper levels. The political troubles in Mexico made it necessary to suspend all work in April 1914. Another start was made at the end of August of that year, but in February 1915 another stoppage became necessary, and the mine is still idle. The report for the year 1915 shows that, during the period from January 1 to February 25, 22,684 tons of ore was treated for a yield of bullion worth £29,400. The local working profit was £11,800. The English company received dividends from the American company amounting to £32,572, mostly coming from accumulated profit, and out of this amount £20,498 was paid to English shareholders, being at the rate of 5%. The reserve of ore yet to be extracted from the mine is estimated at 156,000 tons, and the local working profit is estimated, under normal conditions, at £109,128.

St. John del Rey. — This company was formed in 1830 for the purpose of working the Morro Velho gold mine in the state of Minas Geraes, Brazil. Since 1888 the operations have been in charge of George Chalmers, who in that year rescued the mine after a previous serious collapse of the workings. The orebody is in ancient schists, and descends vertically with a pitch of approximately 45°. In horizontal section it is about 1000 ft. long and 20 ft. wide. The mine is the deepest in the world, the lowest level being 5826 ft. vertically below the outcrop. The report for the year ended February 29 last shows that 201,552 tons of ore was raised, and after the rejection of waste, 192,500 tons was sent to the mill. The yield of gold was £466,501 or 48s. 5d. per ton. The working cost was £284,004, £50,000 was transferred to capital account for shaft-sinking and plant, and £10,000 was placed to reserve fund. After the payment of £936 as interest on the 7% debentures, £10,000 was paid on the 10% preference shares, and £54,627 on the ordinary shares, being at the rate of 10%. As compared with the previous year, the tonnage milled was 1000 tons more, the yield per ton 10d. higher, and the total yield £12,809 more. Of the £13,370 outstanding debentures, £11,570 have been paid off since the close of the company's year. Development during the year has consisted of opening out level 19 at 5526 ft. vertically below outcrop and in driving a cross-cut at level 20 at 5826 ft. below outcrop. The angle of pitch is becoming flatter at depth, and the cross-cut at level 20 has not reached the orebody at the point originally expected. As far as the orebody has been explored at level 19, the length, width, and assay-value compare favourably with those of the levels above. The ore reserve is estimated at 788,439 tons, equal to a 4 years' supply. The temperature of the bottom workings is at present as high as 107°F., and steps will have to be taken to instal the air cooling and drying plant as designed by Mr. Chalmers a year or so ago. When the orebody has been proved at level 20, sinking will be resumed.

Ouro Preto Gold Mines of Brazil.—This company was formed by John Taylor & Sons in 1884 to acquire the Passagem gold mine near Ouro Preto, in the State of Minas Geraes, Brazil. The mine is near the Morro

Velho, worked by the St. John del Rey company, and is in the same geological formation, but the ore is of lower grade. Small dividends have been paid on the ordinary shares in 1895, 1896, 1902, 1908, 1910, and 1911. Reconstruction was necessary in 1893 and 1914. On the latter occasion the ordinary shares were scaled down to £15,000, and the £36,634 preference shares were converted into £12,212 preference and £24,424 ordinary. It was intended concurrently to issue £30,000 new preference shares in order to help development and increase the treatment plant, but the financial conditions were adverse and the proposals had to be deferred until a more suitable opportunity arrived. The report for the year 1915 shows that 85,400 tons of ore averaging 7·3 dwt. was raised and treated for a yield of gold worth £120,591. The working cost was £111,798, and the allowance for depreciation of plant £6467. The preference shareholders received their 10% dividend, absorbing £1221. A. J. Bensusan, the superintendent, states that 5374 ft. of development work was done, a record figure. The width of the orebody has, however, become much less, so that the tonnage of ore developed has decreased, and the reserve has decreased by 37,973 tons to 74,705 tons. There have been few discoveries of importance during the last few years in the deeper parts of the mine. The lode is flat, having a dip of only 15°, and the means of transport of ore and men from and to the lower levels are not as efficient as is desirable. A vertical shaft to cut the lode at depth was started a few years ago, but the work was suspended owing to a heavy inflow of water. Mr. Bensusan points to the increasing necessity of completing this shaft.

Village Main Reef.—This company was formed in London by the Consolidated Gold Fields of South Africa in 1890 to acquire from a South African company a mine in the central Rand below the Salisbury, Jubilee, and the western part of the City and Suburban. During recent years the technical direction has been with Rand Mines, Limited. The life of the mine is not more than two years. The report for the year 1915 states that owing to collapses in the workings, as recorded in our October and November issues, milling was suspended during the last three months of the year, while repairs were made and alternative means of access to the lower levels provided. During the time the mills were running, 357,032 tons was hoisted from the mine, and after the removal of 15% waste, 301,610 tons averaging 8·2 dwt. was sent to the stamps. The yield by amalgamation was 82,336 oz. and by cyanide 37,316 oz., making a total of 119,652 oz., worth £495,257, being 7·93 dwt. or 32s. 10d. per ton. The working cost was £327,582 or 21s. 9d. per ton, leaving a working profit of £167,674 or 11s. 1d. per ton. The repair of the shafts and levels cost £30,008. It was possible to distribute only £94,400 as dividend, being at the rate of 20%, as compared with 70% during each of the previous six years. The ore reserve on December 31 was estimated at 635,050 tons averaging 7·1 dwt., of which 280,100 tons averaging 8·1 dwt. was in the Main Reef Leader, 319,500 tons averaging 6·6 dwt. in the South Reef, and 35,451 tons in the Main Reef averaging 4.1 dwt.

Simmer Deep.—This company was formed in 1906 by the Consolidated Gold Fields of South Africa for the purpose of amalgamating several properties in the eastern part of the Rand on the dip of the Simmer & Jack, Rose Deep, and Glen Deep. Milling commenced in 1908 with a plant jointly owned with the Jupiter, the mine adjoining on the west. Of the 300 stamps in the plant, 180 were used by the Simmer Deep and 120 by the Jupiter. The latter mine was closed in 1913, but was reopened in September last. The share capital of the Simmer Deep is £1,650,000, and there are £791,900 debentures. No dividend has been paid on the shares. The report for the year 1915 shows that 794,476 tons of ore was raised, and 769,100 tons sent to the mill. The yield of gold was 86,381 oz. by amalgamation and 64,015 oz. by cyanide, being a total of 150,396 oz. worth £626,638, or 16s. 3d. per ton milled. The working cost was £581,950, or 15s. 1d. per ton, leaving a working profit of £44,688 or 1s. 2d. per ton. Debenture interest absorbed £45,951, and £9847 was paid as war expenditure, phthisis compensation, etc., so that the year ended with an adverse balance. C. D. Leslie, the superintending engineer, reports that the ore reserve on December 31 last was estimated at 1,585,000 tons averaging 4·4 dwt. per ton, an increase of 156,000 tons and 0·1 dwt. as compared with the year before. The developments at depth during the last year or so have disclosed ore of rather better grade than the average of the mine, and it is hoped that the working profit will be increased accordingly.

Jupiter Gold.—This company was formed in 1896 by the Consolidated Gold Fields of South Africa to acquire property below the Jumpers Deep in the eastern Rand, and in 1907 the adjoining Simmer East was absorbed. Milling started in 1908 with a mill jointly owned with the Simmer Deep. The ore is of low grade, and in order to reduce costs it was proposed in 1913 to increase the scale of operations. The plan, however, had to be abandoned, and later in the year mining was suspended. In May 1915 it was decided to reopen the eastern part of the workings nearest to the Simmer Deep, and the sinking of the Howard shaft and of the Simmer Deep's Rhodes shaft was resumed. The report for the year 1915 shows that from September 1 to December 31 an average of 80 stamps and 5 tube-mills treated 79,600 tons of virtually unsorted ore. The yield of gold was 18,293 oz., worth £76,223, or 19s. 1d. per ton. The working cost was £81,069 or 20s. 4d., so that a small loss was made. But for the usual absorption of gold when starting metallurgical plant, a fair profit would have been made. Since the turn of the year conditions in this respect have improved, and for the purpose of getting still better results resort has been made to selective mining. The ore reserve in the Howard Shaft section is estimated at 952,000 tons averaging 4·8 dwt., and in addition 123,000 tons of partly developed ore has an indicated assay-value of 4·2 dwt. per ton.

Antelope Gold Mine (Rhodesia).—This company was formed in 1908 to acquire gold-mining claims in the West Gwanda district of Rhodesia, about sixty miles south of Bulawayo. The control passed in 1912 from the Rhodesian Exploration & Development Co. to the Gold Fields Rhodesian Development Co. H. A. Piper is consulting engineer. The metallurgical plant was started in November 1913, the funds for its erection having been provided on loan by the Gold Fields Rhodesian Development Co. The report for the year 1915 shows that 47,858 tons of ore was treated for a yield of gold worth £103,271. The net profit was £19,876, which was devoted to the reduction of the loan. The ore reserve is calculated at 110,157 tons averaging 9½ dwt., a fall of 24,340 tons during the year. Developments in the lowest level, the 12th, have been encouraging, and already 13,043 tons averaging 12·6 dwt. has been added to the reserve. On Mr. Piper's advice, the main shaft is being sunk with the object of opening a 14th level.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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REVIEW OF MINING

Introduction.—Attention this month has centred upon the war, the simultaneous offensives of the Allies being much too dramatic to permit thinking of ordinary matters until their scope and effectiveness be determined. The general tone is cheerful, though there is no false feeling of security as to an early termination of the war. There is, though, a belief that the first great difficulties have been overcome and that from now on the contest will not be unequal so far as supplies are concerned. Russia is looking far ahead and preparing for 1918. France is still erecting big-gun factories and even in the United Kingdom the stage of factory-building is not yet passed. Large quantities of raw materials, and especially of metals, will still be needed. Additional purchases of copper have been made in America and there is some discussion of a plan to buy the whole output of certain large mines for the period of the war. The zinc situation is discussed elsewhere. While for the moment prices are a bit lower than they have been, they are still on a profitable basis, and the end is not yet.

Home.—The Murex Co., owning the Lockwood magnetic oil-flotation process, is treating a large proportion of the impure wolfram concentrate imported into this country. The study of the separation of complex ores continues at the works at Millwall under the direction of Mr. H. A. Green. An experimental plant sent to the western America some time ago has been bought locally, and it will be applied to the concentration of lead carbonate ore. The Murex plant at the Cordoba copper mine in the south of Spain is to be extended.

Transvaal.—The output of gold in July on the Rand was 733,485 oz., and in outside districts 27,602 oz., making a total of 761,487 oz., worth £3,232,891, as compared with 735,194 oz., 26,570 oz., 761,764 oz., and £3,235,767 in June. The number of natives employed at the gold mines at the end of July was 192,130, as compared with 192,809 at the end of June, and 190,026 at the end of July 1915.

We discuss elsewhere, in detail, the present situation as regards the Far East Rand, and our Johannesburg correspondent states that plans are being made for development of the deep claims of the East Rand Proprietary mines. In the access of interest in the Far East it must not be forgotten that there is room for much expansion on the Central Rand. Crown Mines is now opening what is virtually a new deep mine comparable to a Far East Rand venture. The East Rand Proprietary is evidently about to undertake an active programme of deep mining. Mr. George Denny has been studying the Cinderella Consolidated and has reached the conclusion, after resampling, that mining should be resumed and that an extensive programme of development is warranted. It is probable that this will be done. It is not to be forgotten that a large factor at least in the closing down of the Cinderella was the unsatisfactory conditions and high cost of mining from a single shaft. No area sufficient to warrant mining on the large scale necessary is likely to be developed in these deep mines in the face of the technical and financial problems involved in mining from a single shaft.

Some months ago we announced that the life of the New Goch mine was limited. The chairman of the company, Sir George Albu, gives four years as the life. He also stated that negotiations were in hand with the City Deep whereby the New Goch would work 21 claims belonging to the latter company, on a profit-sharing basis the details of which are still to be settled.

The sinking of a second shaft on the Daggafontein has been commenced at a point 6000 ft. west of No. 1 shaft. It will be remembered that the latter shaft intersected the banket in September 1914, at a depth of 3580 ft., where the ore was found to average 7·8 dwt. per ton over a stoping width of 40 inches. Driving from this old shaft is in progress. It is reported that the reef continues thin but rich.

Rhodesia.—The output of gold during June was worth £333,070, as compared with £323,783 in May, and £322,473 in June 1915.

The meeting of the Gold Fields Rhodesian Development Company afforded a review of metal mining in Rhodesia, since, as Messrs. J. G. McDonald and Geo. Mitchell point out, the group produces 35·53% of the gold and 30·86% of all the mineral output of southern Rhodesia. Incidentally it contributed 72·96% of the increase of output for the year. Of the various properties controlled, the Shamva and the Falcon have become the big producers. The former treated 576,640 tons yielding 103,291 oz. gold at a profit of £195,241, with a working cost of 8s. 5·46d. per ton and an extraction of 98·3%. The Falcon treated 200,223 tons (including oxidized ore) averaging 5·21 dwt. per ton in gold and 2·04% copper per ton. It is difficult to estimate profits exactly, but taking copper at £50 per short ton, the total amounted to £336,246. Actually the company did much better than this, but the round figure is taken for the sake of uniformity in estimates. As a whole the Gold Fields faces a serious depreciation account owing to the fact that in a new country it is impossible to pick all winners among prospects. The facts were stated frankly by the chairman and a reconstruction is proposed. Another direction in which there has been disappointment is at the Cam & Motor, concerning which a special report by Mr. C. B. Kingston has been made public. He states that stoping shows so far ore of a value materially below that indicated by carefully checked estimates made on development sampling. He suggests that in orebodies of such erratic character as replacement ores containing gold in arseno-pyrite it is entirely possible that the final average will substantiate the original estimate. This is borne out by the finding of the high-grade free gold streak on the lower levels which has already been developed enough to show that it is important, though Mr. Kingston refuses to commit himself by valuing it. In the meantime the mine is behind in development and a vigorous policy in this direction is recommended. The truth seems to be as to the whole of Rhodesian mining that mines excellent in themselves have been over-valued and asked to do too much. Such courageous facing of the facts as evidenced in the speech of Lord Harris and the report of Mr. Kingston, are the first steps toward getting upon a right basis. In the meantime mining is sustaining, even as it is, a country of large value to the Empire and of great potentialities.

West Africa.—The output of gold during June was worth £127,107, as compared with £132,976 in May, £135,289 in June 1915, and £147,289 in June 1914. Abbontiakoon, Abosso, and Prestea Block A all show slight declines. The figures for May and June at Ashanti Gold Fields and Taquah showed little variation.

The Wallis Company was formed in 1910, as a re-organization of the Wallis Syndicate formed the previous year, for the purpose of prospecting over a concession 50 miles east of the property of the Ashanti Goldfields Corporation, in West Africa. An outcrop of auriferous conglomerate had been discovered, and the shares of the company were boomed on the market. The report of Mr. George Macfarlane, who recently visited the property, imparts to the business a more prosaic appearance. He gives detailed information of various workings, which have reached a 3rd level, and he estimates the developed ore at 65,400 tons, averaging $8\frac{1}{2}$ dwt. per ton. Taking the working cost at 25s. per ton, a working profit of 10s. per ton should be obtained. The country is much faulted, and this condition, taken with the exhaustion of the company's funds, seriously discouraged the directors, but they are encouraged by Mr. Macfarlane's recommendation to sink and open a fourth level, and the shareholders have given their consent to this policy.

Australia.—The directors of the Mount Lyell company have secured a modification in the option on the Rosebery group of zinc-lead-silver mines in Tasmania. The war conditions prevent any raising of capital at present, so by the new arrangement the period is extended to June 30, 1917, or six months after the termination of the war, whichever is later.

The ore deposit at the Great Fingall Consolidated appears to be exhausted, and the work is now being centred on the mining and milling of the remaining ore. It is estimated that 31,010 tons averaging 35s. 4d. per ton can be readily mined, and that 4990 tons can be taken from pillars. Probably also 20,000 tons can be extracted from the ground between the 18th and 19th levels. It will be remembered that, toward the end of last year, an arrangement was made whereby the West Australian government agreed to advance £15,000 for the purpose of exploring at depth. The small amount of work thereafter done made it evident that the expenditure of the full amount would not be justified. We shall regret the disappearance of the Great Fingall from the list of producers, for in its earlier days its name became identified with the modern principle, as enunciated by Mr. C. A. Moreing, of charging all expenditure to revenue account.

The Briseis group of tin mines in north-eastern Tasmania suffered from drought during the first half of 1915, so that the output of block tin, 382 tons, was smaller than it would have otherwise been. During the first half of 1916 the output was 223 tons. The old Briseis property is exhausted, and Krushka's Flat will not last much longer. The Ringarooma property is much lower in grade than the Briseis, the yield per yard being about $\frac{2}{3}$ lb., and the removal of the hard undecomposed basaltic overburden adds to the expense. Before long the Ringarooma will have to be diverted once again, in order to bring the water-supply to the point where it is needed.

A company has been formed in Australia, called the Metal Manufacturers, Limited, for the purpose of producing copper wire, sheets, and tubes. The Mount Morgan company is supplying £20,000 working capital, and other backers are the Hampden Cloncurry, the Electrolytic Refinery Co. of Australia, and the British Insulated and Helsby Cables Co.

During the year ended May 31 the Mount Morgan produced 8307 tons of copper and 120,131 oz. of gold. A contract for the delivery of 6000 tons of copper to the Russian Government during 12 months was made at current prices for electrolytic, and the remainder of the output is sold to the British Government at £100 per ton. The estimate of ore reserves has been revised, and at the end of May stood at: High-grade ore 951,400 tons averaging 3·48% copper and 9·81 dwt., medium grade 2,827,700 tons averaging 2·42% copper and 9·81 dwt., low-grade 360,300 tons averaging 1·19% copper and 6·9 dwt. gold, and basic ore 129,200 tons averaging 2·46% copper and 1·02 dwt. gold.

Canada.—Agitation for the prohibition of exports of nickel ore and the refining of all the produce of Canadian nickel mines in the Dominion has increased since the announcement that the German submarine *Deutschland* was loading at Baltimore with a quantity of nickel. It is held locally that despite the precautions taken to prevent nickel refined from Canadian ore being supplied to the Germans, the latter must have been able by some means to obtain Canadian nickel, as there is little from any other source manufactured in the United States. Public feeling in Canada has been aroused on the question, and the course of the government in continuing to permit the export of nickel matte to the American refineries is forcibly condemned, even by many supporters of the Borden administration. In order to allay the popular excitement, the government has issued a statement repeating what has been announced on former occasions as to the measures taken early in the war to prevent Canadian nickel falling into the hands of the enemy, with the full approval of the British government, which regards these precautions as sufficient. The statement goes on to point out that the supposition that the nickel secured by the Germans is from Canadian mines is based on the erroneous belief that no other nickel is refined in the United States. A report by Major Graham A. Bell, who is entrusted with the duty of supervising the destination of Canadian nickel ore refined in the U.S.A., is given to the effect that a considerable quantity of nickel ore is obtained from various American copper mines and some is imported from New Caledonia and refined in American plants. This official deliverance is received with a considerable degree of incredulity, and the agitation, judging from the attitude of the press of both parties, appears to be daily gathering strength and bids fair to imperil the position of the government. The provincial government of Ontario is equally strenuous in denying the possibility of any of the output of the Sudbury mines falling into German hands, and announces that it contemplates the establishment of a government nickel refinery, and with that object in view has spent a considerable sum in testing new patent processes for refining. It was announced some months since that the International Nickel Co. of New Jersey, under agreement with the Canadian government, had undertaken to construct and operate a Canadian branch plant, and more recently active steps toward construction have been taken. It is also announced that the British-American Nickel Corporation, which controls the Murray mine and other properties brought together by the late F. S. Pearson, is about to build works in Canada, using the Hybinette process. This is the one used at the Evje works in Norway and is said to be especially applicable to low-grade ores.

Zinc concentrate consignments from the Slocan district in British Columbia amounted to 11,801 tons for the first six months of 1916, as compared with 5199 for the same period last year.

South America.—Good reports come from the McGuire property on the Nechi river near Medellin, Colombia. At the present rate of production the season's yield will be about £30,000. The gold is in placers, some of the ground yielding 12 to 16s. per cubic yard. It is worked by hydraulic elevators, built by the New York Engineering Co., and a profit is reported on gravel containing 7½d. per yard. As much as 30,000 yd. has been handled in one month in one 12-in. elevator with water under 300 ft. head. A view of the pit is shown herewith.

McGuire Placer Mine in Colombia.

Mexico.—The political tension between the United States and Mexican Governments caused the withdrawal of the American members of the staff at the Santa Gertrudis silver mine, Pachuca. The operations are now in the hands of English and Mexicans. The ore now being treated is of lower grade than that milled during the last few months. Further particulars regarding Mexico are given in our San Francisco letter.

United States.—The fall in metal prices has set everybody gossiping and questioning.

The most serious setback was that faced by spelter makers, but even so, the present price is above normal and most of the big companies have sold ahead. Probably, if war orders do not develop, some of the plants will be forced to close, which is exactly what was anticipated from the first. They will have made their profit and with poor plant and expensive fuel could not expect to run in ordinary times. It is interesting to note that with spelter at 8c. and 9c. per pound there were good inquiries from galvanizers. As about half the spelter made in the United States is used for galvanizing, this is encouraging as indicating that even at prices much above normal consumption may be kept up. The copper producers are not worried and have not cut prices, some three-quarters of the production being sold ahead. Minor metals, such as tungsten and antimony, have dropped most but, however distressing to individuals, this is unimportant in a large way, since the amounts concerned are small. The actual business of mining in the United States continues large and prosperous.

Russia.—The Russian Mining Corporation reports that delays in the delivery of pumping plant have made it impossible to unwater the Zyrianovsk lead-zinc-silver mine in the Altai to the lowest level at 760 ft. An inspection of the other levels has confirmed the old reports and maps. Diamond drilling has proved the continuance of the orebody to a point 100 ft. below the lowest level, and the probable ore has been increased thereby by nearly a quarter of a million tons.

Excellent progress is being made by the Irtysh Corporation in bringing the Ridder mine to a producing stage. The first spelter turned out at the Ekibastus smelter proved to be of excellent grade and a second unit of the plant should be ready by the end of the year. Construction of the lead furnace is being pushed and the stack should be put into blast by the end of the year. The output of the furnaces will depend mainly upon the amount of concentrate that can be brought down the river during the present shipping season. For the present river equipment is limited.

The Orsk, as we anticipated, has presented an excellent report with receipts at £102,700 as against £80,300. The Kolchan dredge returns are up to 2s. 2d. per yard, an increase of 1s. The Pokrovsky treated a smaller amount of richer gravel.

Korea.—The Kuhara firm, which we mentioned last month as having purchased the Kapsan mine, is, we understand, negotiating for the dumps at Taracol belonging to the Oriental Consolidated. It is estimated that in the dumps there is 300,000 tons of 5 dwt. tailing available, but transportation difficulties would seem to forbid any but local treatment, though at Chinampo the Kuharas already own a smelter which treats concentrate from Suan.

China.— Interest in London has centred in conflicting announcements regarding the Eastern Pioneer Co. Ltd., owners of the Pritchard-Morgan concession in Sze Chuan. The mineral resources of this province were described for our readers last month by Mr. Herbert W. L. Way, engineer for the Eastern Pioneer Co. The Morgan concession was granted in 1898, but exploration begun by Mr. Way, Dr. Jack and others was stopped by the Boxer rebellion. For various reasons the work was never resumed. About a year ago the Central Mining & Investment Co., and S. Pearson & Son joined in a plan to finance and develop the concession which in the meantime had been reconfirmed at Pekin. G. G. S. Lindsey and Robert Anderson were sent to investigate. They have recently returned and Central Mining and the Pearsons' have abandoned the project, it being announced that it was found impossible to secure certain changes in the terms of the concession regarded as essential. The Eastern Pioneer Co. is now negotiating with a view to forming an Anglo-Japanese company to finance and operate the properties. The original concession is curiously phrased and provided for the formation of a Hua Yi Co. of Chinese, to own properties to be selected and operated by a Hui Tung Co. which was to include Chinese and foreign shareholders. The Hua Yi Co. was never formed, the work having been interrupted before the work of selection was completed. There seems little reason to doubt that the territory includes important deposits of both metals and petroleum; the practical problem is to establish a sound basis for working them.

EDITORIAL

MELTING down gold coins is now forbidden by the Government and jewellers will have to look elsewhere for raw material. It would seem that this would operate to put free gold at a premium.

WATER problems impose a severe strain on mine managers. Mr. Kotzè notes elsewhere the amounts of water encountered in sinking on the Far East Rand. We note by a recent news item that the Old Dominion management in Arizona is pumping about 6,000,000 gallons per day at a cost of about 4s. per ton of ore, and feeling rather cheerful since the amount had been up to 11,000,000 gallons.

IN our wonder over the unusual we sometimes miss the wonder of the usual. Much has been said of the cost of building the Panama canal, it amounting to about the same as the total capitalization of the Rand mines, but during the period of its building the Bell telephone interests spent twice that amount in extensions and renewals in the United States. Because the money was spent in 70,000 communities by a private company it attracted much less attention than the dramatic work of the American government on the Isthmus.

MINE TAXATION is a particularly lively subject just now and we make no excuse for going into it at some length. In London the incidence of the excess profits tax has raised many questions. Fortunately, the Institution of Mining and Metallurgy has taken the lead in presenting the case of the mines and has obtained recognition of the principle that the interest return must be larger than in ordinary business since the dividend masks a continuous return of capital. Under the leadership of the Institution an important meeting of those interested in mining was held at the River Plate House, August 8, and arrangements were made for systematic representation of the mines before the government in regard to all matters relating to taxation. A strong and representative committee was appointed consisting of Lord Harris, Sir Lionel Phillips, Sir Alfred Mond, Sir Trevredyn R. Wynne, and Messrs. F. W. Baker, Edmund Davis, F. A. Govett, F. H. Hamilton, Henry Taylor, Leslie Urquhart, Oliver Wethered, and Robert Williams. We sincerely hope that this may presage a real reform in mine taxation.

RAND MINING is more in the public mind now than at any time for several years and with due apologies to our friends in other districts, we take this month extra space in order to discuss in some detail the financial and economical problems involved in its further development. Without going into the matter at length at this time, we may express the hope that the *ignis fatuus* of state mining will not lead our friends so far that a return to the trail is too late to connect with the capital now undoubtedly available for Far East Rand mining.

AUGUST is popularly regarded as the silly season so far as new books go, but anyone reading our review pages this month will, we believe, class this as another unfounded generalization. It is an embarrassment of riches to have at one time new books by Henry M. Howe, James Park, L. V. Pirsson, Charles Schuchert and Theodore Hoover, to say nothing of an interesting first book by Mr. D. M. Liddell, whose shorter articles have led one to expect much. We are fortunate in commanding the kindly services as reviewers of friends outside our staff—Messrs. H. C. H. Carpenter, Henry Louis, J. W. Evans and C. E. Bannister—reviews by whom are compliments to any author indeed. Mr. Hoover's book on flotation is discussed by Mr. Edward Walker of our regular editorial staff, and whose knowledge of flotation goes back to the days when his first article on the subject was rejected by a Pundit editor with the comment that he must have got things mixed up, since "heavy minerals do not float." That editor is only one of the many who has lived to revise his opinions.

HIGH prices for zinc have expanded the profits of the English Crown Spelter Co., which has mines in Italy and a smelter at Swansea. For 1913 the net profit was £4044. For 1915, after the payment of extra taxation, £16,800 was distributed among shareholders and £27,500 was placed to reserve. Another example of big war profits is given by the Roburite & Ammonal company, which is reaping profits from its ammonal powder. Ammonal is a mixture of aluminium dust with a nitrate, and it is now being used extensively in hand grenades. The net profit of the company for the past year was £62,000, as compared with a previous average of £7000. The dividends have been scarce hitherto, and the 20% for 1915 was greater than the total of all the previous dividends. In addition £29,600 was placed to reserve, and £11,900 was carried forward.

AN interesting sidelight on the mental attitude in London is thrown by the comment of *The Financial Times* on the report of William Beardmore & Company, one of the important shipbuilding and general engineering firms having works on the Clyde. The editor expresses surprise and some disappointment that this firm only shows an increased profit of £13,100 as compared with 1914, though the editor remarks that "the deduction of the excess profits' duty on this occasion must make a respectable difference." Considering that the net profit was £232,200 and that, after paying 6% on both preferred and common shares, there was a carry forward of £195,300, such comment can only mean that we have become so accustomed to big war profits as to rather lose our balance. We think of the country as hard hit by the war, but we are dismayed if, despite increase in taxes, wages, and cost of materials, profits do not still break records. As a matter of fact business is in good condition. The productive capacity of the country has been speeded up to where it can carry the war burden and still conduct business as usual in total if not in detail. Exports in May 1916 were better than in May 1914 and, making all allowance necessitated by the increased price of commodities, this is still a wonderful performance. It means that the effective man-power devoted to industry in the United Kingdom is approximately as great as in normal times, despite the absence of millions of men at the front. The war sacrifice is personal, not industrial.

Sir William Ramsay.

The late Sir William Ramsay was perhaps the most energetic and daring investigator in chemical science that the British schools have produced. Many of his discoveries were epoch-making, and their ultimate influence can be but dimly appreciated at present. He, with Lord Rayleigh, identified argon, the inert gas of the atmosphere, and subsequently he established the fact that argon was only one of a group. Among mineralogists he will be remembered as the chemist who found that certain varieties of pitchblende contained helium. Dr. W. F. Hillebrand, of the United States Geological Survey, had been puzzled with a pitchblende obtained in Norway. Ramsay examined the gas obtained by the action of sulphuric acid on Hillebrand's pitchblende, and on cleveite and bröggerite, and found it to contain an element that had been identified by Lockyer in 1868 as a constituent of the sun's chromosphere. In subsequent experiments with radium, Ramsay discovered that its gaseous emanation, niton, gradually changed into helium. He thus established a case of transmutation of the elements. In some further experiments, he claimed to have proved that, under the influence of radium emanation, the higher elements of the carbon group, such as silicon, titanium, and zirconium, broke down with formation of carbon, but other investigators failed to confirm these reactions. His energies were not by any means confined to what we may call the mysteries of chemistry, for he was a helpful investigator in many of the more ordinary lines of research. For instance, he was well known for his work on atomic weights, vapour densities, and other branches of physical chemistry. In his early days his researches were connected with the organic compounds now much sought by the makers of explosives, a fact that may explain his active advocacy of strenuous measures for the prevention of the entry of such things as cotton into Germany. To metallurgists his suggestion that the salts in sea-water serve to precipitate the mud or slime brought down by the rivers opened a new line of investigation. Geologists knew him as the nephew of Sir Andrew Ramsay, formerly director of the Geological Survey and professor at the Royal School of Mines. The mining and power engineer was overwhelmed by his sweeping suggestion that coal should be distilled below ground, and the cost of mining and transport thereby saved. Sir William's role in chemistry was that of a pure scientist, and in this way he presented a contrast to another great chemist recently dead, Sir Henry Roscoe, who was a sagacious adviser in chemical industry. Sir William was not always happy in his commercial associates. On two occasions, to our knowledge, has his name been used by City promoters in a way that could only prove disconcerting to him. He was happier as a teacher and organizer of research, and the world of science owes many a debt to him for inspiration and encouragement.

The Bawdwin Mines.

The Bawdwin lead-zinc-silver orebody is one of the largest and richest, if not actually the largest and richest, mineral deposits now in course of development. We have on several occasions given the history of this property, and have recounted how the company was formed originally to smelt rich lead slags left behind by the Chinese workers, and to follow the ore below the oxidized zone. As recently as March last, Mr. J. D. Hoffmann gave a comprehensive summary of the venture in our pages. Two years ago the Burma Corporation was formed to acquire control and supply adequate capital for further development, and pending the completion of the company's own plans for treatment, contracts were made for the sale of the mixed sulphide ore to Germany. These contracts are now inoperative. In view of the probable difficulty of obtaining Treasury sanction for the issue of additional capital for the completion of the development and concentration schemes, a change in the plans was necessary in order that the cost of this work may be defrayed out of revenue, at a time when the prices of metals, especially lead, are high. Details of these plans and particulars of progress were given by Mr. Theodore Hoover, Chairman of the Technical Committee, at the recent meeting of shareholders, and we cull from his remarks the information following.

The policy of the company has been to develop the Chinaman orebody by means of an internal shaft sunk from the adit level, and concurrently to drive a new adit 7250 ft. long, known as the Tiger Tunnel, to intersect the orebody at the 6th level. This tunnel will deliver the ore to a point convenient for the Namtu smelter, besides providing drainage facilities and giving the necessary ventilation. Driving from the open was commenced in April 1914, and in January of this year, on the internal shaft reaching a sufficiently deep point, a drift was started from the bottom to meet the adit workings. If all goes well connection may be expected by the end of next month, and after that, it will be possible to expand the development operations. The ore developed by June 30 was estimated at 2,850,000 tons averaging in round figures 27% lead, 22% zinc, and 25 oz. silver per ton. It is anticipated that at least a further 650,000 tons will be developed above the Tiger Tunnel level, making 3,500,000 tons in all. The inner core of the orebody is richer than the average, and is estimated to contain 600,000 tons averaging 40% lead, 23% zinc, and 37 oz. silver per ton. The tests by jigs and tables, in a plant having a capacity of 100 tons per day, show that two commercial products can be obtained. First, a lead concentrate averaging 55% lead, 14% zinc, and 45 oz. silver per ton; and second, a zinc concentrate averaging 45% zinc, 10% lead, and 15 oz. silver. The concentrator is to be extended to a capacity of 1000 tons per day, and by smelting some of the lead concentrate, and selling the rest of the lead concentrate and all the zinc concentrate, a profit of one million pounds per year, or £3 per ton of ore, may be expected. This estimate is based on pre-war prices of metals, with lead at £16 per ton, zinc at £23, and silver at 2s. per oz. In order to obtain these results, it is anticipated that £200,000 will be required for the completion of the equipment of the mine and mill. These funds can be obtained from two sources. In the first place the corporation has cash resources and uncalled capital amounting to £95,000, besides 35,000 unissued shares which could be placed to advantage at any time. Secondly, the present rate of output of lead and silver is yielding a large profit. During 1915, the output of lead was 14,000 tons, selling at £23 per ton and bringing with the silver a gross return of £325,000, out of which the whole of the development expenditure and the cost of driving the Tiger Tunnel was paid, and £70,000 allocated for the reorganization of the smelter and the mill. It is probable that during 1916 the sum of £75,000 will be available for similar purposes. By these various means the funds covering the necessary capital expenditure will be readily found without any appeal to the public. The plan based on an output of 1000 tons of ore per day does not provide for the smelting of the whole of the lead concentrate, or for the smelting of any of the zinc concentrate. The provision of capital for the expansion of smelting operations in connection with either lead or zinc is necessarily postponed until the status of the metal industry within the Empire is finally settled. Before concluding this statement of the position of the Burma Corporation, it is well to add that the relations with the Indian Government have been greatly improved recently, and that both the Government officials and the railway administrators, recognizing the excellence of the corporation's commercial and technical methods, are giving their practical support on every suitable opportunity.

War Taxes and Rand Efficiency.

War times bring many burdens both direct and indirect, and the gold mines on the Rand are not escaping their share. It will be recalled that last year a special war levy amounting to £500,000 was made on the mines. At the time it was stated that this was to be a special and temporary assessment. Now it is decided to increase the amount, and to make its collection an annual event as long as the war lasts. Remembering the large contributions to the Government regularly made by the mines, both through direct taxation and the indirect form of railway rates, it might be thought that some protest would be recorded at this renewed assessment. We are glad to announce that not only has there been none, but that all along the Rand this and other war burdens have been assumed without complaint. There, as elsewhere throughout the Empire, the first thought is the winning of the war. In the matter of taxation in general, a cynic might allege that the miners have become so used to unequal treatment and that they accept it as a matter of course. In the Transvaal there is no land tax, and in South Africa only about 8% of the income tax is collected in the country. Speaking broadly the mines support the Transvaal, and contribute heavily to the support of all British South Africa. This is certainly unequal taxation, but it does not follow that it is unfair or unjust. Despite the probable long life of the Rand, and we are not among those who foresee its imminent collapse, mines do represent accumulated wealth. Mining does take capital out of the ground, and, as compared with farming, manufacturing, commerce, and ordinary industries, it has in any one locality or state a limited life. Provided that the portion taken by the Government be applied to capital expenditure and not frittered away in meeting current liabilities, even the miners affected recognize it as proper that the mines should contribute heavily to public funds. In the Transvaal, railways, roads, schools, public buildings, and many other things properly chargeable to capital account are still widely needed despite the most excellent beginning that has been made. So far as the money taken from the mines is applied to such purposes the programme rests on sound statesmanship, and the miners accept it in good part. There is some question whether in fact too much of the revenue so derived is not being used in spoon-feeding poor whites and whether such measures do not tend more to alleviate than to eradicate distress. That is a matter concerning which an outsider may not fairly judge. There is also a question whether taxation is not reaching the point where it discourages development, as in the case of the Far East Rand, where the Government has repeatedly offered areas for leasing, and found no takers, because of the terms proposed. We discuss this phase of the matter elsewhere in this issue. Here it is our pleasant privilege to record the acquiescence of the mining public in the broad plan to have the mines make large contributions to the permanent upbuilding of the country, and we may call attention to the fact that where ownership, as on the Rand, is largely in the hands of non-resident shareholders, it is only through incidence of taxation that this can be accomplished. If the shares were all or mainly owned locally it would be immaterial whether the Rand mines were taxed or the necessary moneys raised by assessments against the shareholders as citizens. So much for the general philosophy of taxation of the mines.

The war levy might be thought to fall within the inhibited scope of temporary expenditure, and to be an instance of using capital to meet current account. No doubt there is justice in this view, and the war is, in fact, being fought in Africa as elsewhere by drawing on capital. Without accepting altogether the opportunist excuse that the money must be taken by those who have it, we can foresee material returns from the capital expenditure. Not all the money spent on war is wasted. The line built to connect the South African railways with those of South-West Africa will remain and serve a good economic purpose. It is also announced that the wells sunk and stations built to permit the expedition to cross from Kuruman to Keetmanshoop are to be maintained so as to furnish a new trade route. We have seen too many 'deserts' vanish before the tide of settlers backed by transportation lines to despair of the Kalahari, and the agricultural and industrial conquest of Bechuanaland may well result from the means adopted to meet a temporary situation created by war. South Africans generally, and among them those on the Rand no less than their fellows at the Cape and on the veldt, are in a cheerful mood as to the war and the sacrifices it involves. Facing an assured and brilliant future they can well cultivate a philosophic attitude toward the troubles of the present. No prospector worries much about mosquitoes when he sees gold in his prospecting pan.

Fortunately also there are compensations in war as in peace. Disregarding entirely the intellectual and moral quickening that the people of South Africa are receiving in common with those of other parts of the Empire, there is the matter of the increased efficiency shown at the mines. It is probably true that the greatest resource available in any country is the reserve force of its people. In emergencies men enormously increase their energy output, and under proper stimulus any people can and will accomplish much more work with equal or greater satisfaction to themselves than under less stimulating conditions. Men who lay 800 bricks per day in one country lay 3200 to 4000 in another and are, if anything, the happier for it. It is said that in the newer munition works the women labourers are turning out a larger per capita output than obtained in pre-war days among skilled workmen. The difference is in the mental stimulus and the moral enthusiasm generated by working directly for one's country, and in the better equipment of the plants and organization of the work. The Rand, as is true of all other great work centres, had, and still has, an enormous reserve of human energy. One does not need to be long underground or to spend many hours around the surface plants, to see the effect of dull, deadly routine in slowing the pace of the labour. It is a source of loss that will always be present where so much work is to be done that is so much the same from day to day. Coupled with this is the presence of native labour which here, as elsewhere, tends to a decrease in the efficiency of the white workman. Not all white men are gifted to supervise, indeed the proportion is small, but where the rough work is allocated to the black man all white men must become bosses, and as time goes on that means an enormous proportion of contractors and minor officers who have never really learned their jobs and who always work at a slow pace. Theirs is a thinking part, and too many of them think slowly if at all. With low-priced native labour at hand, the tendency is always to meet any situation by putting on another boy or two, and through it all the white man draws big pay and takes it easy.

The war has called from the mines many of the best white men. More would go if they could be spared, and while it is true, and a matter of wide comment, that the veldt rather than the towns has furnished most of the men called for by Generals Botha and Smuts, large numbers of the best men have gone to the defence of their country. As always in such case the proportion of energetic, forceful men, those full of initiative, is larger among those who go than those who remain, but in the general readjustment at the mines the men behind, particularly those of the mining staffs, have responded most amazingly to the stimulus of new duties and added work. Indeed there is more than one company which has reported decreased costs with a smaller force of white men. In part this is due to the less amount of supplies bought, since the mines have been living to a considerable extent on stocks purchased before the war, in part it is due to substitution of cheaper materials found as a result of the inventive genius called out by the situation, but in the main it means more actual work done by each white man remaining at the mines. It is true that the supply of native labour has been unusually good, indeed work is being 'made' at some mines to keep the boys employed and so as not to discourage recruiting. The normal ratio of white men to natives is 1 to 8. Now it is 1 to 10 for the Rand as a whole and in many mines is even higher. It is to be hoped and expected that the mines will retain permanently some of the benefits of this enforced improvement. Too many inefficient white men are still employed and the standard of labour is too low. This is in large part due to political conditions, but it is also in places at least the result of poor organization. The war has demonstrated a little of what improvement is possible, and the lessons of adversity should bring rewards in time of prosperity. There is such a flux of labour on the Rand that it will be entirely possible to take back the men who return from the war, and who have been promised their positions when they do return, and still hold the advance in efficiency. Merely not filling vacancies as they occur will shortly adjust the balance. When a mine which grants half-pay to one-third its men away on war duty can still operate without decreasing profits, and that has proved true in at least one case, it argues a slackness in pre-war days that should not be allowed to be resumed. The lesson is not for the Rand alone, but managers everywhere may well ask themselves whether they are using their men to the best purpose and stimulating them to that high plane of productiveness which, while not leading to accumulation of fatigue, is good both for man and for industry.

Russian War Taxes.

War taxes are the order of the day in all countries, not even neutral Spain and the United States having escaped. The former has just advanced its rates and, as we note elsewhere, Congress at Washington is even now busy at increasing both the Customs tariff and internal revenues. Russia is the latest country to announce an excess tax, and this is of particular interest since it falls heavily upon mining companies, of which many largely owned abroad are only now coming into production. The Russian authorities have a difficult problem to face in financing the war. It will be remembered that at its very beginning more than one-fifth of the ordinary revenue of the Empire was wiped out by abolition of the liquor traffic. Excellent as the sociological results of enforced sobriety have been, the financial problems faced by the Czar's ministers were made no easier by this sudden taking away of some £65,000,000 of ordinary revenue at a time when extraordinary expenditures had to be met. So far the attempt has been made to meet the situation by increasing the rates of normal taxes. Stamp duties, real estate taxes, and house taxes were raised and in November 1914 the regular capital and profits taxes were increased by 50%. At that time a limit was set and it was enacted that the total taxes should not exceed 30% of the net profits. Now this limit is raised and an excess profits tax is added to those already in force. A mining company operating in Russia has therefore to face a variety of taxes. In addition to zemstvo or local rates, there are the so-called fundamental taxes, the capital tax, the profits tax, and now the excess profits tax. Zemstvo and fundamental taxes are not ordinarily high, and in calculations affecting profit-making enterprises they may be neglected, since they are covered by the profits tax. The capital tax, originally 15 copecks per Rs.100 or 0·15%, and now 50% greater or 0·225%, is levied on all incorporated companies. The normal profits tax is graduated, and while it has been frequently changed, it ranges from 3% when profits are 3% to 14% when profits are between 19 and 20%, with 10% excess where the net profit exceeds 20%. This, as well as the capital tax, was increased 50% late in 1914.

The new excess profits tax is also graduated and the rates are as below, no such tax being collected where the excess profits amounted to less than 8%.

Rate return on capital	Rate of tax
8	20
9	21
10	22
11	23
12	24
13	26
14	28
15	30
16	32
17	34
18	36
19	38
20	40

It is provided that the maximum taxation shall be 50% as follows: "If the amount of tax on excess profits calculated as above *(a)* for the fiscal year 1916, together with the tax on profit, or *(b)* for the fiscal year 1917, together with tax on profits and income tax, in total exceeds 50% of the profits liable to taxation, then the amount of tax on excess profits is so reduced that the total taxation does not exceed 50% of the profits." It is assumed that this new tax only applies to the residuum after collection of the capital and normal profits taxes with their 50% increase.

The situation will perhaps be made clearer by an illustrative calculation. For this purpose let us assume a company capitalized at Rs.16,000,000 and making in 1915 a profit of Rs.5,000,000 as against Rs.2,000,000 average for 1913 and 1914. In such a case the rate of profit, before taxes were applied, would be 31¼%. The total tax would work out as follows :

Capital tax :		
Normal tax 0·15% on Rs.16,000,000 ...	Rs.24,000	
50% war increase ...	1,200	
		Rs.36,000
Profits tax :		
14% on profits up to 20% = 14% of Rs.3,200,000 ...	Rs.448,000	
24% on the excess over 20% = 24% of Rs.1,800,000 ...	432,000	
50% war increase ...	440,000	
		Rs.1,320,000
Total usual taxes ...		1,356,000
New war tax :		
Rs 5,000,000 nominal profits 1915		
Less 1,356,000 usual taxes		
3,644,000		
Less 2,000,000 profits 1914		
Rs.1,644,000 of which 40% ...		657,600
Grand total ...		Rs.2,013,600

This is equivalent to a trifle over 40% of the net profit and it reduces the actual profit to some 19% on the capital.

There is in Russia furthermore a general income tax, and since several of the Russian mining companies are owned by British companies, the question arises whether the latter, as distinct from the Russian company, must pay an income tax. Since in the case supposed the income would exceed Rs.400,000, there would be a further tax of Rs.48,000 with with Rs.1250 for each Rs.10,000 additional. This, as will be seen, would seriously deplete the funds of the British company. However, we are informed that such British companies are not held to be domiciled in Russia and hence have only British taxes to face.

The total rate of taxation levied in Russia is limited, as will be seen, to 50% of the net profits, though the value of this restriction is somewhat lessened by the fact that a previous limit of 30% was promptly raised when the State needed more money. While, therefore, the rate is still less than a British company investing at home may have to face, it is impossible to say what it may become in the future. Also it is to be remembered that in the case of British companies there is double taxation. This is becoming so heavy as to raise serious question as to the utility of a British holding company to own shares in foreign or colonial enterprises. It is impossible to forecast the outcome now, since so much will depend upon the rapidity with which war taxes are wiped out when the markets are again open to trading. There are many advantages in maintaining an entrance to the London market, and doubtless in arranging the future programme of taxation the authorities will keep in mind the fact that home taxes, added to those of the country in which the profits accrue, must not be placed so high as to destroy the value of a British company.

What might well prove an even more serious matter for the present is the fact that most Russian companies have so far been reinvesting their profits in their business. It might easily happen that an excellent profit on the books, and hence subject to tax, was represented not by cash but by new works built perhaps to serve government purposes. The Kyshtim has built acid and dynamite works as an incident to taking war contracts from the government. To the extent that the money for the building of such plant has been taken from the undivided profits, the latter are not available for paying taxes. Fortunately the Russian authorities have recognized the validity of this argument in advance and have provided that profits reinvested in plant used on government contracts may be deducted before the tax is applied. This has the obvious effect of placing a premium on reinvestment and so tends to keep the new capital in Russia and available for helping the government. Customs tariffs are also being raised so as to increase the protection given local producers. It may also be pointed out that since the profits tax depends upon the rate of profit, it may be reduced by increasing the nominal capitalization of a company.

Russian financial ministers have a peculiarly difficult problem. Since the old vodka revenue came from the masses, it would seem that the natural method of making good for its absence would be by taxes on such things as salt and matches, that are used by everybody in roughly equal per capita amounts. There is a tax on matches, but it is only estimated to yield Rs.20,000,000, as against Rs.651,000,000 net decrease in the vodka tax. To make up the whole difference and an equal portion of the necessary increases by spreading taxation among the people in general might provoke serious political difficulties, and the unrest of the common people is thought to be the most serious danger that will confront the Russian government in the reconstruction period. The alternative is to tax the classes and particularly the corporations, but here another difficulty arises. Russia, rich in resources, does not have sufficient capital for any quick development and if the new industries necessary to make her economically independent are to be built up, foreign capital must continue to flow into the country. Applying foreign money to industry involves double taxation, and the rate of such taxation is becoming a serious matter. There is, furthermore, the difficulty that no one can foretell what the rate may become. To invest large sums abroad necessitates a long look ahead, and if calculations are to be continually upset by increasing taxes, investors will naturally decline to take the risk. There is nothing that frightens capital more than an unmeasured and unmeasurable risk. The fact that maximum rates duly established have been swept aside in favour of still higher rates, leaves the financier with no basis for estimating. The Russian budget in pre-war days called for about Rs.3,500,000,000, and it is estimated that it may be necessary to raise as much as Rs.5,000,000,000 per year to carry the war to a successful conclusion. Even this sum is not unduly large when the great extent and resources of the country are taken into account, but undeveloped resources count for nothing as revenue producers. The Russian government has previously recognized this fact and has been generous in tariffs, loans, and even direct subventions. This policy must be continued. Russia can only settle foreign debts by exporting goods—wheat, timber, and other materials of which the country has a great surplus. Building up local industries will not only decrease imports and so the amount to be sent abroad but will afford a broader basis for taxation, and in time will add to the exports. The prosperous country, the one which is going ahead, is the one in which more and more property is coming into use. Not higher rates of taxation but more goods to be taxed is the road to sound government finances. We are glad to note that even under the great stress of the moment, Russian authorities recognize these facts and, while increasing taxes, as indeed they must, are arranging their fiscal system so as to stimulate domestic production.

FAR EAST RAND AND SUGGESTED CHANGES IN THE GOLD LAW.

By R. N. KOTZÈ.

An analysis of mining conditions in the Far East Rand with a study of what constitutes a minimum area for profitable working and a plea for modification of the gold law.

*FOR purposes of this discussion the 'Far East Rand' will be taken to include all the ground containing the Main Reef series and situated east and southeast of and including the farms Rietfontein No. 11 and Witpoortje No. 12 and extending up to the limits of the outcrop and sub-outcrop of the Main Reef series. The area extends about 20 miles in an east-west direction and 22 in a north-south. It is estimated that over 203 square miles (88,191 claims) the reef lies at a depth of less than 5000 ft. and that only in the southwest corner does it lie at more than 7000 ft. depth. The farms already proclaimed are 19 in number and include 29,567 morgen or 42,577 claims (a Transvaal claim is roughly equivalent to 1½ acres). Upon the proclaimed farms 18,045 claims are held by existing mining companies, 6404 are otherwise held, 1286 are open ground, and 16,842 are reserved from pegging. There are 22 farms in the area unproclaimed and including 45,043 morgen or 64,863 claims. Of these the reef is believed to lie at less than 5000 ft. depth under 48,396. Under 9836 claims it lies between 5000 and 6000 ft. and under 6631 below 6000 ft. Of the unproclaimed farms Springs Mines holds 1382 claims under mining title on De Rietfontein 14, and 20 others are held by the Marievale Nigel on Holgatfontein 127, on Daggafontein 25, Grootvlei 26, and Klipfontein 22. Shaft sinking has been carried on by the owners of the farms, but mining title has not yet passed for the ground which they are entitled to select. Roughly three-quarters of the ground to be proclaimed is available for leasing.

The reef-bearing area may be summarized as below:

	Claims
Held by existing producing companies	14,203
Held on proclaimed ground by companies or individuals and requiring further capital for development and exploitation	10,246
Open for pegging	1,286
Reserved from pegging and available for leasing	16,842
Held under mining title on unproclaimed land	1,344
Not held under mining title on unproclaimed land	63,519
	107,440

The existing producing companies may be looked upon as being adequately provided with capital. The remainder, 93,237 claims (of which 19,249 are over 5000 ft. in vertical depth), will require capital which may be roughly calculated at £1000 per claim. Large allowance must be made for areas that may never prove sufficiently attractive to induce development, and the £50,000,000, roughly estimated as necessary, will be spread over a number of years.

It is obvious that caution must necessarily be exercised in the opening up of new ground, in order to minimize the heavy losses inseparable in proceeding from proved to unproved territory, and that a prudent financial policy will discourage the taking of too long leaps in the dark.

It will appear that there are now available for leasing on proclaimed ground a total area of 16,842 claims. When the remainder of the reef-bearing land is proclaimed, amounting to 64,863 claims, about three-quarters of it, or about 48,000 claims, will become available for leasing, bringing the total approximately to 65,000 claims, of which 49,200 contain reef at a depth of less than 5000 feet.

The salient particulars as to the operations of the producing companies working within the area and the results achieved may be summarized in the following tabulation:

As at December 31, 1915	Producing companies Outcrop	Deep level	Total
Number	4	7	11
Total reef-bearing area, claims	3,934	10,269	14,203
Total capital expenditure as at 31.12 14	£1,634,634 (a)	£6,536,134 (b)	£8,170,768 (c)
Total tons milled	17,996,024	8,685,860	26,681,884
Total gold recovered	£28,994,451	£14,016,059	£43,010,510
Total gold recovered per ton milled	32·22s.	32·27s.	32·24s.
Total dividends declared	£7,587,383	£3,552,882	£11,140,265
Total dividends per ton milled	8·43s.	8·18s.	8·35s.
Total present rate of crushing per annum	1,850,000	3,100,000	4,950,000

(a) This is the capital expenditure of the New Modderfontein only, and is as at June 30, 1915. Figures for the New Kleinfontein, Nigel and Van Ryn mines are not available.

(b) The capital expenditure of the Sub-Nigel is not included, the figures not being available.

(c) This total is subject to above exceptions *(a)* and *(b)*.

There are in addition eight now producing companies, of which five control 5174 claims and three have their selections still to make. The total capital expenditure amounts to £2,935,421 and at present only the Springs has developed such ore reserves as to lead the

* *Condensed from a 'Memorandum on the Far East Rand by the Government Mining Engineer,' submitted to the Parliament of the Union of South Africa.*

company to undertake provision for ore treatment.

The official lives of the present producing companies in this area, estimated upon a conservative basis, and on their existing crushing capacities, range from 6 to 40 years, and average 21 years. The majority of the companies have announced the intention of increasing their reduction plants, and this will naturally result in more rapid exhaustion of the ground. It must, however, not be forgotten that when a mine is nearing the end of its life, it is invariably found that a good deal of ore can be extracted from the mine, which it is difficult or impossible to include in any engineer's estimate of payable tonnage. As a consequence, the actual life of a property is always longer than that given in the official estimates.

MINING CONDITIONS. — The Far East Rand consists of gently undulating country, traversed by broad flat valleys, and affords good facilities for the laying out of equipment, sidings, quarters, etc. The coal measures cover the greater portion of it, but over a stretch of seventeen miles of country from Knoppiesfontein 30, on the north, to Vlakfontein 21, on the south, where they have been denuded, the underlying dolomite is exposed. The width of this stretch of dolomite is on the average about two and a half miles, but the portion extending from Modderfontein 17, on the west, through Geduld 24, Grootvlei 26, to Palmietkuil 61, on the east, is as wide as nine miles. The exposures of the Upper Witwatersrand system are few and scattered, the most extensive one being that of its upper portion, the Elsburg reefs, on the farms Withok 149, Vlakfontein 26, and Grootfontein 152, while the exposures on the Main Reef zone are of very limited extent, occurring only on the farms Benoni 10, Kleinfontein 9, Vlakfontein 18, Modderfontein 17, Klipfontein 22, Bultfontein 28, Varkensfontein 217, and Noycedale 71.

The cost of shafts, as far as published data show, has been as follows:

Company	Shaft	Cost per foot £	s.	d.	Depth to which this cost applies Feet
Daggafontein G.M. Co., Ltd. ...	—	50	16	6	3580
Springs Mines, Ltd.	North	47	10	6	3433
"	South	49	5	7	3260
Geduld Proprietary Mines, Ltd.	No. 2	35	12	6	1725
"	No. 3	46	3	9	1847
Rand Klip, Ltd.	East	45	2	6	1857
Cloverfield Mines, Ltd.	—	43	5	9	2043
Brakpan Mines, Ltd.	No. 1	33	11	5	3129
" "	No. 2	32	17	10	3777
Government G.M. Areas (Modderfontein)	N.E.	33	12	10	2376
" " "	N.W.	30	13	3	2422
" " "	S.E.	30	19	1	2985
" " "	S.W.	28	15	9	2470
Van Dyk Proprietary Mines, Ltd.	No. 1	22	10	2	1656
" " "	No. 2	27	10	9	1057

The wide distribution of the dolomite with its accompanying water has in certain instances added considerably to the difficulty and cost of shaft sinking, and has also increased mining costs. The following statement gives the average amounts of water pumped or baled by the mines in this area:

Mine	Average number of gallons pumped or baled per day of 24 hours during 3 years ended 31.12.13
Springs Mines	1,952,000
Geduld Proprietary	1,826,000
Brakpan Mines	665,000
Govt. Gold Mining Areas (Modderfontein) Consolidated	632,700
Daggafontein	523,300
New Kleinfontein, Apex section	460,000
Van Ryn Deep	417,000
Welgedacht Exploration	307,600
New Modderfontein	264,500
New Kleinfontein, Kleinfontein section	262,200
Modderfontein Deep Levels	223,700
Van Ryn G.M. Estate	113,500
Modderfontein B. Gold Mines	108,600
Rand Collieries	83,000

The water pumped and baled from mines shut down prior to 1913 was as below:

Mine	Period	Average number of gallons pumped or baled per day of 24 hours
Grootvlei Proprietary	Year ended 30. 6.10	524,600
Rand Klip..................	2 years ended 31.12.12	417,500
Cloverfield Mines	2 " " 30. 6.10	172,400
Van Dyk Proprietary.	3 " " 30. 6.10	86,700
New Kleinfontein ...... (Benoni section)	2 " " 31.12.12	73,200

The dip of the reef over almost all this area is slight, and there are portions of it of considerable extent in which it averages about 8°. The locality where steeper dips obtain is in the northwestern portion of the area, where dips at outcrop of 70° at the Van Ryn and of 60° at the eastern section of the New Kleinfontein exist. These steep dips rapidly flatten, and in the neighbouring properties of the Apex section of the New Kleinfontein, the Van Dyk, the Rand Collieries, the dip averages 20°, and in the New Modderfontein 22°. At the southern extremity of the area the dip varies from 20° at outcrop in the Nigel to 12° in the lower levels of the Sub-Nigel. The average dip of the unexplored area may be assumed to be 7 degrees.

Mining and boring operations have shown that over almost the whole area only one reef has been or is likely to be worked. The portion in which this condition does not obtain is that comprised by the Van Ryn, in which mine as many as four have in places been worked in separate stopes one above the other with partings of a few feet, and the Kleinfontein section of the New Kleinfontein, where three have in places been worked in separate stopes one above the other with partings of a few feet. In these mines, as well as in the

New Modderfontein, a reef known as the South or Modderfontein Reef, lying 470 ft. (true thickness) above the Main Reef, has been worked to a small extent. For purposes of estimating probabilities in the unexplored areas, an average stoping width of 4¾ ft. will be assumed.

In most mines there exist non-productive areas from which no ore is obtained, either because it has never been deposited, or has been cut out through faulting or the intrusion of dikes, or is required to be left for purposes of safety, or is of so narrow a width, or so low a value as to be unpayable. The proportion of these non-productive areas is smaller in the outcrop mines in the northwest portion of the area. The percentage of non-productive area varies from 15 to 80 in different mines, on the basis of the existing relations between recovery and costs. In estimating the possibilities of the ground still to be worked, 60% of any area to be worked will be assumed as non-productive. This assumption will naturally be too optimistic in certain cases, and too drastic in others. While there are indications that the poorer ground lies in certain directions, our present day knowledge of the conditions does not permit any clear line of demarcation between payable and unpayable areas. Further exploration will in time no doubt indicate the promising sections more definitely.

It is laid down in section 46 of Act 35 of 1908, that the area to be leased shall constitute a workable mining proposition. In determining the minimum size of such an area, many factors have to be taken into consideration, and a fairly liberal margin must be allowed, for otherwise the proposition becomes unattractive. An error on the large side makes the proposition more attractive, but one on the small side might make it hopelessly unpayable. On the financial side it will be assumed for the purposes of this memorandum that by a "workable mining proposition" is meant a mine returning annually over a period of 20 years, after paying its share of profits to the Government, a dividend of at least 15% on the capital sunk, and also a further sum which invested at 3% compound interest will at the expiry of this period amount to the capital invested. The capital so invested, referred to subsequently as 'accrued capital,' is the amount spent on shaft sinking, equipment and advance development, plus interest at the rate of 6% up to the date of commencement of production. These assumptions necessitate a dividend of approximately 18¾% on the accrued capital when the life is 20 years. This may seem high, but, considering the risks run, such an expectation is by no means an unreasonable demand. On the technical side the determining factors are the number and depths of the shafts, which will vary with the area of the property, the size of equipment, the recovery, the costs and the quantity of payable ore per claim.

Of the areas available for leasing, the most attractive and suitable are those lying alongside proved payable mines such as the Brakpan Mines, Geduld Proprietary, and Springs Mines. The following may be assumed to be the average reef conditions in these areas: Proportion non-productive, 60%; dip, 7°; stoping width, 4¾ ft.; sorting, 20%; tonnage per claim, 8170 tons from stopes, and say 830 tons from other sources, or a total of 9000 tons per claim; the depth of reef will be from 3000 to 5000 feet.

The average recovery already obtained from the area as a whole was:

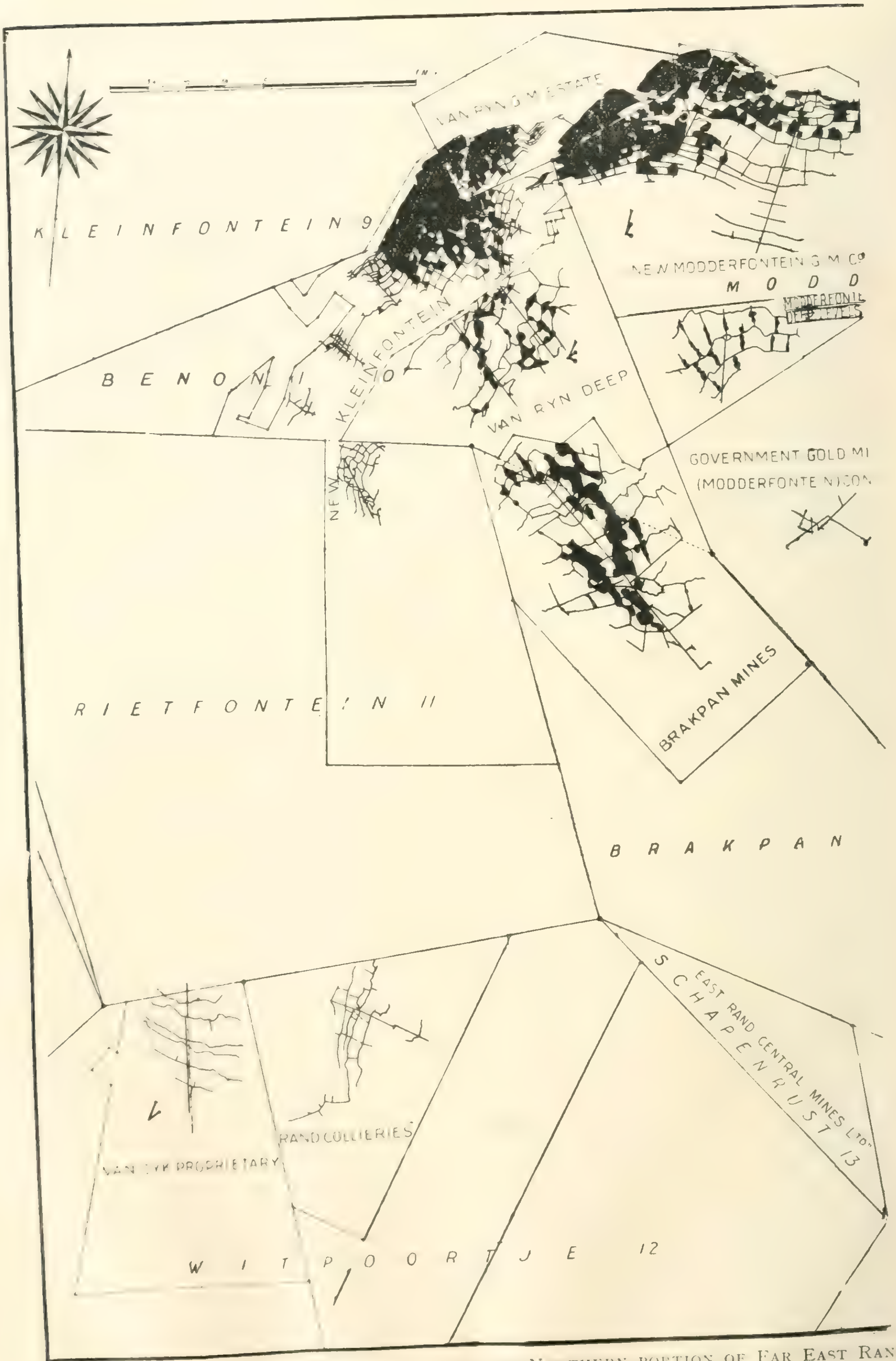
	Per ton milled Shillings
Up to December 31, 1915	32·24
During year 1913	32·02
During year 1914	31·11
During year 1915	31·88

The recoveries per ton milled by the various producing companies for the years 1914 and 1915 have been as follows:

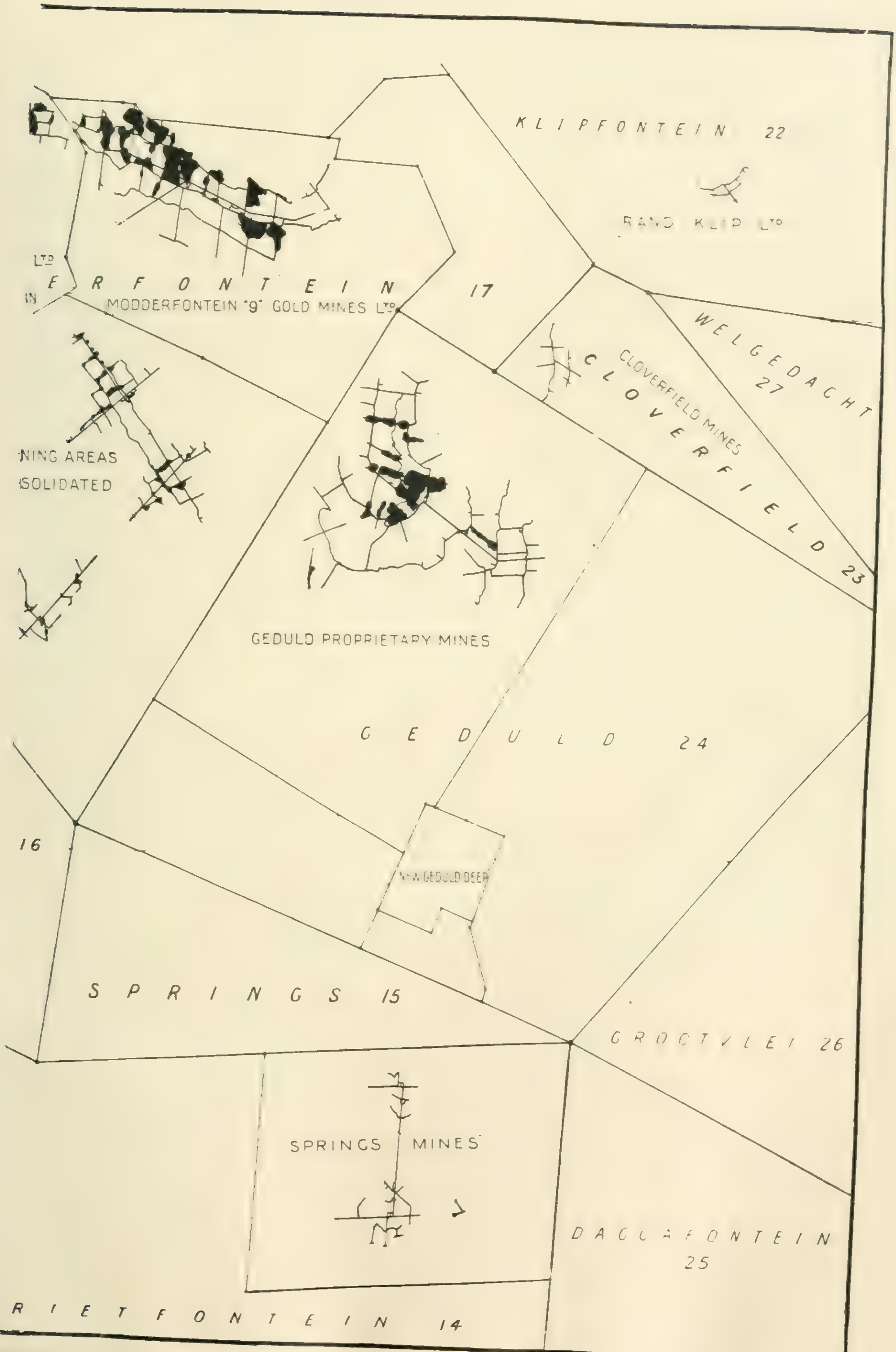
Company	Recovery per ton milled during Year 1915 Shillings	Year 1914 Shillings
Brakpan Mines	28·19	27·64
Geduld Proprietary Mines	30·83	32·34
Government G.M. Areas (Modderfontein)	24·98	16·57
Modderfontein B. Gold Mines	41·54	35·83
Modderfontein Deep Levels	33·83	—
New Kleinfontein Co.	26·15	26·68
New Modderfontein	40·52	37·47
Nigel	27·95	30·00
Sub-Nigel	40·68	40·13
Van Ryn Deep	37·37	33·38
Van Ryn G.M. Estate	24·59	26·18

The Government Gold Mining Areas only commenced crushing in October 1914, and has not yet been milling ore up to its average grade. In the Springs Mines the ore in reserve at December 31, 1915, after mixing with one-ninth of its quantity of low-grade ore from other sources, would yield a recovery of 45s. In the Daggafontein G.M. Co. the assays where the shaft cut the reef indicate a recovery of 29s. 8d. A recovery of 27s. 6d. per ton milled may therefore be reasonably assumed as probable in estimating the possibilities of the area under consideration.

On the above assumptions regarding tonnage, recovery, and other factors, the following are the estimated minimum areas, equipment, capital expenditure, etc., of leases of average depths of 3000 and 4000 ft., with productive lives of 20 years:



MAP OF NORTHERN PORTION OF FAR EAST RAND



SHOWING EXTENT OF UNDERGROUND WORKINGS.

Depth of reef in feet	3,000	4,000
Recovery per ton milled	27s. 6d.	27s. 6d.
Costs per ton milled	18s.	17s. 6d.
Crushing capacity per annum, tons	650,000	1,100,000
Capital expenditure, shafts	(3) £285,000	(4) £600,000
„ „ equipment	£606,000	£825,000
„ „ development	£260,000	£550,000
„ „ total	£1,151,000	£1,975,000
Non-productive period, years	5	7
Accrued capital (*i.e.*, capital expenditure plus 6% interest over non-productive period)	£1,365,094	£2,428,749
Annual recovery	£893,750	£1,512,500
Annual working costs	£585,000	£962,500
Annual gross profit	£308,750	£550,000
Annual amortization allowance	£42,835	£73,501
Annual net profit	£265,915	£476,499
Government's share, equivalent to profits tax	£26,591	£47,650
Government's share over and above profits tax, say	£26,592	£47,650
Company's share of net profit	£212,732	£381,199
Amortization allowance	£42,835	£73,501
Company's distributable profit	£255,567	£454,700
Sinking fund contribution required to amortize accrued capital	£50,803	£90,388
Interest on accrued capital, 15%	£204,764	£364,312
Total milling tonnage	13,000,000	22,000,000
Minimum number of claims required to constitute a mining proposition	1,445	2,445

EXISTING LEASE AND AREAS ALREADY OFFERED FOR LEASING.—Government notices Nos. 687 and 688 of 1909, dated June 16, 1909, asked for applications for the exclusive right to mine precious metals on two areas, in extent 1275 and 1358 claims respectively. The capital expenditure necessary was in each case estimated at £350,000 for shaft sinking and preliminary development, and at a further £350,000 for bringing the property to the full producing stage. Each application required a guarantee of £35,000. Within two months after acceptance of application a limited liability company, to be registered in the Transvaal, having a cash capital of at least £350,000, 25% of the capital required for shaft sinking and preliminary development to be offered for subscription to persons resident in the Transvaal, no person to apply for less than 10 or more than 200 shares. No vendors' nor promoters' shares were permitted, nor any commission for underwriting the capital. The minimum consideration to be paid to the Government for the lease was a per-

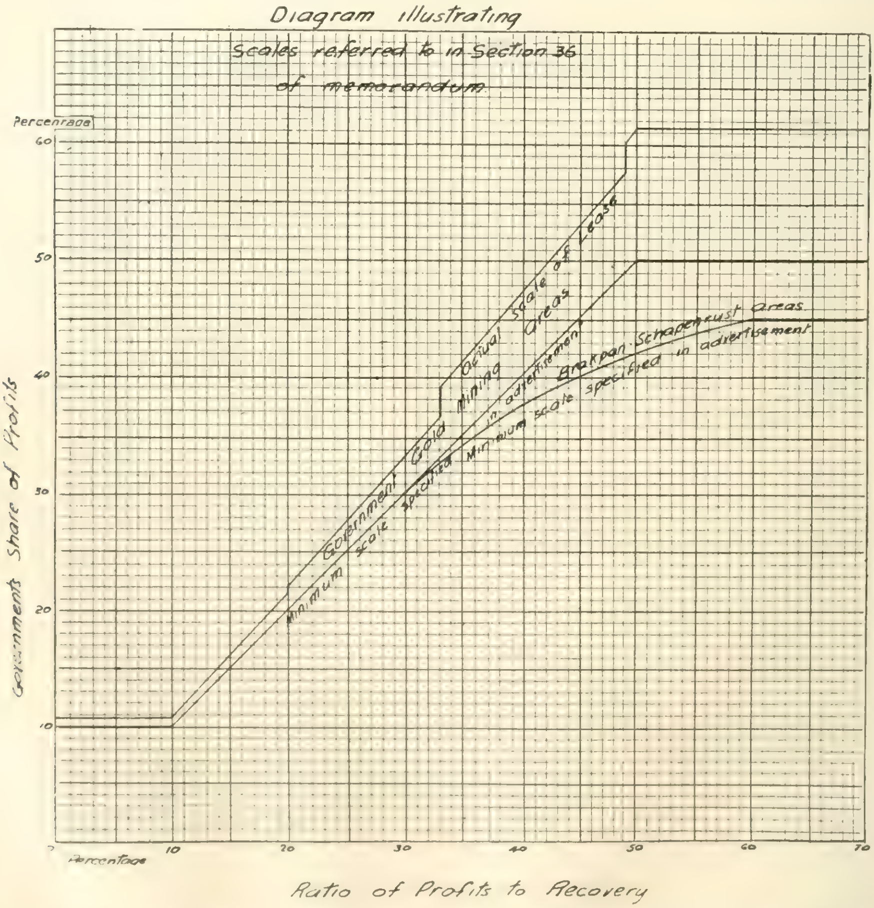


FIG. 1. CURVES SHOWING PERCENTAGES OF PROFIT TO THE GOVERNMENT UNDER THE CONTRACT WITH GOVERNMENT AREAS AND AS SPECIFIED IN ADVERTISEMENTS OF LEASES.

centage of net produce, *i.e.*, the profit less allowance for amortization of capital expenditure, on a sliding scale varying between 10 and 50%.

Two applications were received for each block, and that of Messrs. Barnato Bros., who offered the sliding scale plus an additional amount varying from $7\frac{1}{2}$ to $22\frac{1}{2}$%, was accepted. Fig. 1 shows the minimum consideration specified, and the additional amount offered by Messrs. Barnato Bros. Before flotation the two blocks were amalgamated into one company. This company, the Government Gold Mining Areas (Modderfontein) Consolidated, Limited, was registered on February 26, 1910, commenced shaft sinking in January 1911, and crushing in October 1914. Up to December 31, 1915, it had crushed 673,800 tons, with an average recovery value of 23·76s. per ton. Owing to initial difficulties in starting, and the low grade of ore milled up to December 31, 1914, averaging only 16·57s. per ton, the company worked up to this date at a loss of £24,468. The total capital expenditure up to December 31, 1914, was £1,569,000. It is estimated that a further £80,000 would be required to complete the equipment necessary to crush at the rate of 50,000 tons per month, and a further £250,000 would be required to erect further equipment enabling treatment of 100,000 tons per month. It has been agreed that this sum shall be appropriated out of profits and the Government portion shall be treated as a loan to the company, repayable at the rate of £10,000 per month beginning December 31, 1917.

Subsequently the Government offered, without securing satisfactory explanations, Brakpan 16 and Schapenrust 13 on three occasions, Witpootje 12 once, and Geduld 24 and Springs 15 once.

AMENDMENTS REQUIRED TO THE GOLD LAW.—Section 46 of the law under which leasing is conducted contemplates that the area leased shall be so large that it can be divided into several mining propositions, or at least shall constitute one that is workable. There are, however, scattered areas that are too small for this, the 'bewaarplaatsen.' These can only be leased to adjoining companies on the principle embodied in section 52, which is impossible at present.

Before calling for applications for lease, the law now requires that the ground shall be beaconed, surveyed, and a diagram prepared showing a sub-division into claims. If subsequently an alteration in the area or the boundaries is required, a fresh survey and fresh beacons are necessary. These provisions further contemplate restricting the initiative as to leasing and the shape, size and location of the block to the Government. For these reasons it appears that the survey might very well be postponed until a lease has been successfully negotiated and entered into.

Section 46 now requires the Government, after selecting and demarcating the area suitable for leasing, to call for applications by notice in the *Gazette* and in newspapers. The whole initiative is thus thrown upon the Government, who may not only select an area which may be unattractive for various reasons to a prospective applicant, but may also advertise at a time when money is difficult to obtain. Opportunities for raising money for such leases do not present themselves too frequently, and when they arise they should be taken advantage of quickly. The present method of calling for applications for leases is cumbersome, and it is combined with rigid conditions and the unavoidable long period required for the sending in of applications, for the consideration and acceptance of any application, and for finally embodying the terms of a lease in an agreement. These disadvantages constitute a very serious stumbling block in dealing with leases. What is required is to leave the initiative with those who are to provide the capital. The area to be worked, the capital required, the share of profit offered to the Government, and the various other details should all be left to the applicant to propose to the Government, which can then decline the application or accept it with such modifications as may be mutually agreed upon. The applicant will prepare his financial arrangements before approaching the Government and the provision of capital would be greatly facilitated.

To advise the Government in all matters appertaining to leases, it would seem necessary to create a strong Advisory Board. The system of calling for competitive tenders and the subsequent publication of the terms of any lease entered into constitute the protection against abuse in the existing law. If this be amended, it is necessary to create some alternative machinery to take its place.

Of the several conditions contained in the present Act, the one prescribing that the lessee shall within a specified time provide the capital required for the equipment is onerous, and, in the case of areas absorbed by adjoining companies, not entirely applicable. In certain instances, the lessee would be justified in asking that he should be permitted to put up only enough money to carry on preliminary operations, such as boring or shaft sinking. If after carrying out this work he finds results unsatisfactory, he might prefer to drop the lease. The initial provision of an excessive amount of capital would in such a case have been unnecessary. Where ground is absorbed by adjoining companies, the possible variations in the provision of capital are innumerable, and elasticity is therefore required to meet the various cases. All the disadvantages attaching to the present law can be removed by the simple expedient of requiring the applicant to submit his financial and technical proposals to the Government, for approval or amendment, and incorporation in the deed of lease.

Section 46 (2) (*c*) requires amendment. It should be provided that the lessee should pay: (*a*) the ordinary statutory profits tax and any other mining tax payable by any person working mineral claims; and (*b*) such further share of the profits as the applicant may have offered to the Government and as the Government may have agreed to accept.

Such a division of the Government's share of the profits will show more clearly than at present what amount the Government will receive as partner in the lease. It should also be provided that in certain instances the share of profits under (*b*) may be commuted into lump sums, or into fixed annual payments, as for example in the case of small areas absorbed by adjoining companies. This is the present practice in the case of the small areas disposed of under section 52.

One of the main principles to be adhered to in providing for the Government share in the profits is that any special supervision of the operations of the lessee should be unnecessary. For this reason any assessment which has to take account of any unit, such as the ton, which is not accurately and automatically determined, is not acceptable. The procedure adopted in assessing profits tax is preferable to any other method. This takes into account only the profits, and cannot be falsified except by devices which would also be detrimental to the interests of the shareholders. Since it cannot be foreseen whether any particular area is going to be a highly profitable or only a moderately profitable or even an unprofitable one, it is advisable to express the Government's percentage of profit in the form of a sliding scale, such that the Government's share increases with the profits. In devising such a sliding scale, the same considerations as have been mentioned in the preceding paragraph preclude the adoption of certain bases, such as that of the ton. It would, for example, give rise to constant trouble if the lessee were to have to pay the Government a percentage of profits rising with the profit per ton. A safe basis is the ratio between profits and recovery for the accounting year. If the ratio be calculated as a percentage, the sliding scale can be expressed in terms of this ratio, as has been done in the scales already used by the Government in calling for applications for leases.

As regards the form of the sliding scale, it should be so devised that, while the Government gets an increased share of profits when these increase owing to a higher grade, they should not rise unduly when profits are increased by a reduction of costs. Otherwise efficiency would be penalized. These objects can be best attained by calculating the Government's share of profit in accordance with a general formula of the form $y = a - \frac{b}{x}$ where x is the ratio of profit to recovery, expressed as a percentage, y is the percentage of profit payable to Government, a and b are constants.

It will be found on analysis that the Government takes a per cent. of the profits earned by a reduction of costs.

For example, if a be made equal to 20 and b equal to 200, the formula becomes $y = 20 - \frac{200}{x}$ and the Government's share of profit is as follows:

Ratio of Profits to Recovery	Government's share of Profit	Ratio of Profits to Recovery	Government's share of Profit
%	%	%	%
10	0·0	25	12·0
15	6·7	30	13·3
20	10·0	40	15·0

On this scale, if the lessee reduces costs by, say, 10d. per ton, the Government will, as partner, receive a per cent., in this case 20% or 2d., of such saving. To this must be added the 10 per cent. in respect of profits tax, making the total 30%, or 3d. per ton.

It is felt by the owners of farms in this area that, owing to the narrow width of the reef, its flat dip, the large proportion of the ground in which the reef is either of low grade or does not exist, and the fact that in many farms the reef lies at a considerable depth, the proportion of the farm to which they are entitled as mynpacht is inadequate. Making the same assumptions regarding milling tonnage per claim, recovery and return upon capital invested, as in sections 25, 26 and 27, the following statement shows the areas required for mynpacht and other owner's rights at various average depths:

ESTIMATES OF AREAS REQUIRED BY OWNERS TO FORM WORKABLE PROPOSITIONS.—Reef: Assumed to dip at 7°, of which 40% is productive, with stoping width of 57 in., sorting 20%, mill tons per claim 9000, of which 8170 tons come from stopes and 830 tons from other sources. Life: 20 years. Recovery: 27s. 6d. per ton milled.

Depth of reef in feet	1,000	2,000	3,000	4,000
Working costs per ton milled	19s. 3d.	18s. 6d.	18s. 3d.	18s.
Crushing capacity per annum, tons	340,000	400,000	600,000	1,000,000
Capital expenditure, shafts	(2) £55,000	(2) 120,000	(3) 285,000	(4) 600,000
equipment	£438,000	488,400	595,000	755,000
development	£119,000	160,000	240,000	500,000
Total	£612,000	768,400	1,120,000	1,855,000
Non-producing period, years	3	4	5	7
Accrued capital *i.e.*, capital expenditure plus 6% interest over non-producing period	£686,390	880,588	1,356,286	2,320,340
Annual gross profit	£140,000	180,000	277,500	475,000
Annual amortization allowance for purposes of mining taxation	£22,776	28,597	41,682	69.035
Annual net profit	£117,474	151,403	235,818	405.965
Annual profits tax	£11,747	15,140	23,582	40,596
Annual distributable profit	£128,503	164,860	253,918	434,404
Annual sinking fund contribution required to amortize accrued capital	£25,544	32,772	50,475	86,353
15% interest on accrued capital	£102,959	132,088	203,443	348,051
Total milling tonnage, tons	6,800,000	8,000,000	12,000,000	20,000,000
Number of claims required	756	889	1,333	2,222

The ground in which the reef occurs at an average depth of 5500 ft. is unable to fulfil the financial conditions detailed in section 25, returning only 10·8% and 12·2% on the accrued capital in the case of equipments crushing 1,200,000 and 1,500,000 tons annually.

If the owners' rights be compared with their requirements, due allowance being made for depth, it will be found that the areas due are insufficient in the cases of:

Bloemendal	276 (*a*)	Grootvlei	26
Daggafontein	25	Klipfontein	22 (*a*)
Droggefontein	159 (*a*)	Vlakfontein	26 (*b*)
Geigerle	28	Withok	149 (*b*)
Grootfontein	152	Witpoortje (East portion)	12

In the cases marked (*a*) the existing law is able to meet the circumstances by allowing the proclamation of the whole of the farm or of sufficient of it to provide a mynpacht of the required size. In the cases marked (*b*), either the owners must be satisfied with a less return upon their capital invested or postpone operations until such time in the future as working costs will have fallen. In the remainder of the cases, the feeling of the owners that their rights are inadequate is justified, and the question arises as to how more liberal treatment can be accorded them.

The objection to laying down minimum areas for owners' rights is that sub-division of farms might otherwise take place to such an extent that on proclamation the whole area would fall to the owner. An adequate area could be assured the owner by a provision in the law allowing him, when selecting his mynpacht, and before the ground is proclaimed, to apply for a lease of adjoining ground, which might be granted by the Government if satisfied that owing to the natural features of the reef, the grant is necessary for the purpose of constituting it, in conjunction with the mynpacht and discovery rights, a mining proposition, and that such grant is in the public interest. Alternatively, the principle of rewarding work done, which is already recognized by the granting of discoverers' claims dependent upon the amount of boring, might be extended to the case of shaft-sinking operations by a further reward of ground sufficient to make the total falling to the owner a workable proposition.

It is a matter of urgency to the Union that the Far East Rand should be rapidly opened up. A statement was presented to the Dominions Royal Commission in April 1914, showing that, of the fifty-eight companies then producing on the Witwatersrand, by the end of 1924 only 33 would be still working; 1934 the number would be 20; 1944, 11; 1949, 8. Since that date, two new producers have entered the list, but at the present there is only one developing mine (Springs Mines), so that for many years to come there will only be this one addition to the list.

A further point is that practically all the more promising ground available for new mines contains the reef at great depths. This delays arrival at the producing stage, and at depths of 3000 to 4000 ft. at least five to six years time is necessary. The great importance of the matter to the Union will be appreciated from the calculation that if only one-half of the 73,988 claims in this area not held by producing companies and containing reef at a depth of less than 5000 ft. prove remunerative, after a deduction of 60% for non-productive zones and on the other assumptions herein made, it will yield gold to the value of approximately £450,000,000.

De Beers Consolidated has offered £1 12s. 6d. per share for the outstanding shares of Koffyfontein Mines Ltd., owner of a diamond property in the Orange Free State. De Beers is already the owner of nine-tenths of the shares and has been financing the work for some time. Additional capital is likely to be needed.

THE FAR EAST RAND AND THE GOVERNMENT

By H. FOSTER BAIN.

The Rand mines, directly and indirectly, form the most important source of public revenue in South Africa and new mines must be opened to replace those about to be worked out. The Government Mining Engineer has made far-reaching proposals designed to bring this about. These are examined and criticized by the Editor, who points out defects in the plans at the same time that he emphasizes their good features.

THE Far East Rand is the greatest known gold-field in the world remaining to be developed. The reef-bearing area is of more than 240 square miles extent and of this the reef lies under more than 200 at less than 5000 ft. in depth. Enough work has been done to prove the general continuity of the ore horizon and also that in large areas it is of workable width and value. Less than 14% of the area is now held by producing companies. About 10% additional is held by companies or individuals requiring further capital for development. Roughly three-fourths of the area remains open to mining enterprise. The district is a flat-lying one, well traversed by railways and power lines and has at hand every facility for mining. It is one in which many of the risks inherent in gold mining may be minimized or insured against by acquiring and developing a sufficiently large area, and it is now pre-eminently the centre of interest for gold-mining investors. Whether it be in Johannesburg, London, or New York that the subject of gold production comes up, the conversation soon drifts around to the question, "What about the Far East Rand?"

In answer it may be stated at once that the Far East Rand will yield an enormous amount of gold. Mr. Robert Nelson Kotzè, the able and careful mining engineer who advises the South African government, has estimated that if but one-half of the 73,988 claims in the area not already held by producing companies and containing the reef at less than 5000 ft. depth prove remunerative, even deducting 60% of the reef as unprofitable to mine, the yield of the gold will approximate £450,000,000. So large a sum challenges attention, and in so great an amount of gold the whole commercial world has an interest. Whether it be added to the working stock now or later, and the speed with which it may be brought out and put to work, is a matter of no small importance.

The rate at which the Far East Rand is opened will depend not solely upon the ordinary laws of economics, but upon these laws and the policy of the Union of South Africa. It chances that almost absolute control is in the hands of the government. Individual private holdings remaining in the area are not large enough to warrant the investment of the large sums, £1,000,000 to £2,000,000, experience has shown to be necessary safely to open and equip a mine in this field. The government holds the gold-mining rights under most of the land and the terms upon which the government will permit mining will largely control the rate of local gold production. The matter of these terms is about the liveliest subject in South Africa today and Parliament at the session which has just closed constituted a Select Committee to examine into and report upon the situation. At that time matters had come to somewhat of a deadlock despite the success attending the ventures already made in the area. The government had adopted the policy of leasing the ground in large blocks, but since 1910 had failed to find any companies prepared to contract with it. Meanwhile mines on the Central Rand are approaching their end and unless new mines be opened *pari passu*, industry will suffer and public revenues will be seriously affected. While the depths of the Central Rand are by no means yet plumbed, the immediate field for increase in production is the Far East, and the opportunity for securing capital for development there is undoubtedly much better just now than on the Central Rand.

It is not that mining in the Far East has just begun, but rather that the success of the various deep mines has only now convinced the public of the possibilities of the region as a whole. Without going far into the geology of the district, which has been most admirably discussed by the government geologist, Dr. E. T. Mellor*, the area may be likened to a great shallow basin open to the west, in which direction the beds dip down to unexplored depths. The outcrop of the reef is known and mapped on the north and the south. To the east it lies under later beds,

* See *The Mining Magazine*, November and December 1915, for summary of papers read before the South African Geological Society; and March 1916 for digest of papers read before the Institution of Mining and Metallurgy, February 24.

but has been approximately determined by boring. The beds dip moderately toward the centre from the outcrop, but over most of the basin lie at very slight angles, 7 to 10°. They have been crossed by a few faults which, while rarely of more than 250 ft. vertical throw, disturb considerably the flat lying working where they are encountered. The reef is cut by dikes and quartz veins, but without material influence upon either it or its gold content. Generally speaking the area is a broad pitching trough of fairly undisturbed sediments, the conglomerates and quartzites of the gold-bearing series being covered over much of the area by the water-bearing dolomite and later coal measures. Dr. Mellor regards the reef mined as the extension of the Main Reef Leader of the Central Rand and as representing a fossil placer laid down under special conditions which he has analysed. With these conclusions we heartily agree.

But one workable reef is known over most of the area, though along the outcrop two or more have been worked and in some of the boreholes the Elsburg, an upper reef, gave promising assays.

Mining began in the Far East Rand as early as 1888 along the outcrop both on the north and the south, though neither then nor for many years later was it recognized that the same reef was being worked. No serious attempt was made to develop the interior of the basin until after the South African war. Before this attempts had been made to explore the area by boring, but as late as 1904, when F. H. Hatch reported upon the properties of the East Rand Mining Estates, the only mining operations were along the outcrop. Such work as was being done was on a small scale, the New Modder, now one of the giants of the area, having only crushed a half million tons in the ten years extending from 1896 to 1906. Drilling was especially active in the years 1902 to 1908, and by 1905 the reef had been found at various points $7\frac{1}{2}$ to 10 miles down the dip from the outcrop. It was then known in the Weldgedacht, Cloverfield, Geduld, Brakpan, Grootvlei, Palmeitkueil, Reitfontein, Witepoort, Daggafontein, and Vlakfontein properties. The first company to begin a deep vertical shaft was the Geduld. Sinking commenced in 1902 and the reef was penetrated in Shaft No. 2 late in the year 1905. This was more than two miles from the nearest workings in Modder B. Six months later Shaft No. 3 entered the reef 3000 ft. further down the dip. The Brakpan, which lies almost as far down the dip from the Van Ryn as Geduld lay below the Modder, completed its drilling in 1903 and began sinking in 1905. The reef was intersected in Shaft No. 1 at 3088 ft. in October 1907, and in Shaft No. 2, 4400 ft. further down the dip, at a depth of 3695 ft. in 1908. Farther west in the Apex, Van Dyk, and Rand Collieries the reef was also opened down the dip from the Van Ryn, though with results that were disappointing commercially. The Van Dyk was drilled before the war, but only began sinking in 1905. The shaft reached the reef at 1550 ft. in December 1906. Rand Collieries sank to the reef in 1908. Far to the northeast the Rand Klip began sinking in 1909 and reached the reef in 1912, as did also the Cloverfield. Between these extremes of territory mining became increasingly active. In 1908 the Van Ryn deep, with the Van Ryn above and the Brakpan below already on the reef, began to sink, getting the reef in one shaft at 1700 ft. in 1909 and in the other at 1625 ft. in 1910. New Modder continued to develop well in depth and results at and below the seventh level being favourable, in 1911 began a deep vertical shaft. Modder Deep proved the reef by boreholes as early as 1902, but only began sinking in 1910. The reef was found at 2990 ft. in August 1912. The next year the 'circular shaft' of the New Modder connected with the reef at 2158 ft. In 1910 the Barnato interests took a lease from the government on the area then surrounded by producing mines and now known as Government Areas. Four shafts were sunk without preliminary drilling. Their depths and date of completion are as listed below:

Shaft	Feet	Date
Northwest	2395	June 1912
Northeast	2275	Aug. 1912
Southeast	3580	May 1913
Southwest	3508	Oct. 1913

The success of these various enterprises, and particularly of the Brakpan, lead to the opening of the Springs, the latest successful mine and one which is just now coming into production. The ground had been drilled as early as 1903 but sinking was not begun until 1909. A most unusual flow of water was encountered, but the shafts were completed by 1913. The finding of workable ore here at just under 4000 ft. depth in shaft No. 2, and $3\frac{1}{2}$ miles down the dip from the nearest workings, illustrates the unusual character of the Far East Rand goldfield. An even more notable extension of the known area was when Daggafontein, which began sinking in 1910, found the reef at 3580 ft. in 1914. This was four miles from Springs and fully 10 miles down the dip from the outcrop to the northwest. Shafts have been begun at various other points and on the south rim in the Nigel and Sub-Nigel there are extensive workings. There are now eleven producing mines in the area of which 7 report a capital expenditure of £8,170,176. The entire group has produced £43,010,510 of gold from 26,681,884 tons, and paid £11,140,265 in dividends. Production is now at the rate of 390,000 tons per month and is being increased to 450,000. The ore reserve stands at over 25,000,000 tons. The total gold recovered per ton milled has averaged 32·24 shillings.

These results apply only to the work so far done by the producing mines. All of them have in reserve large areas wholly undeveloped and, as already suggested, their total holdings constitute less than 14% of the field. The importance of bringing the remainder into production, at least as rapidly as mines on the Central Rand close, is fully appreciated at Pretoria and Capetown. South Africa is a great country of undeveloped resources. The government is not yet adequately housed despite the many most excellent public buildings that have been or are being erected, school facilities are still inadequate, and the railway system is far from being complete. Scarcely a beginning has been made in the building of public roads, irrigation works, and other facilities that must be supplied before the country can become agriculturally great. At present it does not feed itself, and it only lives by virtue of the gold, diamonds, and feathers exported. Vigorous efforts are being made to stimulate agricultural development, and public works are being planned and built in all parts of the country. All this requires capital and the South African governments are peculiarly dependent for this, as yet, on the mines. It is variously estimated, according to the particular basis adopted, that from 60 to 70% of the public revenue is derived directly or indirectly from mines and 45% from those on the Rand. This amounts to about 9s. 4d. per ton of ore crushed. Any decrease in this source of revenue would be a serious matter for the entire country.

THE FAR EAST RAND, ILLUSTRATING THE GREAT DISTANCES BETWEEN SHAFTS. GOVERNMENT AREAS IN THE FOREGROUND, GEDULD IN THE DISTANCE.

According to testimony submitted to the Select Committee on East Rand Gold-Bearing Areas, by Mr. E. A. Wallers, chairman of the Chamber of Mines, the next seven years may be expected to see the closing of mines now producing £8,000,000 per annum and of which £5,000,000 represents working costs and £3,600,000 the amount spent within the country. Taking a longer view, Mr. Kotzè estimated some time since that by 1929 companies which produced half the output of 1913, will have worked out their areas. In detail, by 1924, 24 mines now producing £10,000,000 per annum may be expected to have closed; by 1934, 13 more accounting for £10,500,000 will have been finished; by 1944, 9 more will have closed, reducing the output still further by £7,500,000; that is in 30 years the output will have fallen from £38,000,000 to £8,000,000. According to the report of the Dominions Royal Commission, of the £27,000,000 annual revenue of the Union, £12,000,000 comes from the mines of the Rand. It is clear that unless other sources of revenue be built up before the mines cease to produce, it will be impossible not only for the country to progress but even to hold its own, and that in the meantime production must not be allowed to fall. Added to these financial difficulties is the burden of the war. While, if the Union be allowed to absorb the conquered South-West, the public property in that territory will balance the money spent in its conquest, that matter is still in doubt. Actually the territory is held in trust for the Imperial government and the Union has not only had to finance its taking, but is now being called upon to expend money to guard and govern it. In East Africa the same problem must be faced with, possibly, even less certainty of reward.

There are only four ways of meeting the financial problem suggested. These are:

1. By reduction of expenditure. This is impracticable since even the most drastic cuts would not balance the budget for long and would have the effect of stopping work upon which the whole future of the country depends.

2. By loans. Doubtless this measure may be adopted temporarily and to a limited extent, but a loan without adequate provision for interest and sinking fund soon discredits and bankrupts a government. A loan to meet current expenses is only sound when simultaneous steps are taken to increase revenue.

3. By increased taxation. This again may be applied to a limited extent, but in many directions taxation is already so high as to discourage industry—remembering that in South Africa the railways are a recognized means of indirect taxation. There is as yet no land tax and its absence is generally imputed to political rather than economic conditions. It must be admitted, however, that farming does not appear to be in such prosperous condition as would warrant any heavy taxation.

4. By increasing productiveness of the country. This is undoubtedly the sound and statesmanlike policy. South Africa has large resources and if they be vigorously developed it is abundantly capable of supporting a government that will do everything for its citizens that may be asked of any progressive government.

The most immediate field for development is gold mining and, specifically, the Far East Rand. From mines opened in this district the government may expect to receive not only the same benefit as from mines in the Central Rand, but in part at least an even larger share of the profits. The reason lies in the fact that here the government has retained its mining rights. These are subject to the mynpact rights of the landowners by which the latter are entitled to select roughly one-fourth of the area of their farms for mining under the general law. There are also small areas held under mining titles or open to pegging, but a dominating portion of the acreage is in the hands of the government. Its position is all the more secure since the remaining mynpact areas are hardly large enough to warrant opening mines upon them alone. A company which wishes to spread its risk over an area sufficiently large to protect the heavy investment necessary, is almost forced to deal direct with the government. The latter, after leasing one block to the Barnatos has failed to place additional leases. Five times it has offered areas and only twice have there been tenders. Of these only one was found to be acceptable and the general consensus of opinion was quite fairly stated to the Select Committee referred to by Mr. C. B. Kingston when he said: "The general feeling is that such a tender will never be made again. We regard it as unsound business to offer as much as that." Mr. Gustav Imroth, who made the tender, has pointed out serious defects in the scale as adopted and has made repeated efforts to secure a change. It is perhaps significant that the Consolidated Mines Selection Company, which has had as large an experience as any other house operating in the region and has achieved marked success, refused to bid on government offers of highly desirable territory immediately adjacent to the Brakpan and undertook instead the financing of Daggafontein, a long leap into the undeveloped territory, but a property where negotiations could be concluded with a private company.

There has been a disposition on the part of some to assume that failure to bid on the areas offered for lease merely means that the Rand houses have agreed among themselves to hold up development until they can get the territory on their own terms, and out of this has grown an agitation for state mining. While possessing no esoteric knowledge in regard to the matter, we think it entirely possible that the Rand houses have each for himself, or possibly after comparing notes, decided that it was better to do no business just yet in the Far East Rand than to do it on the terms previously offered. If so, we commend their judgment and, that this is believed by others to be the correct explanation of the failure to bid, is indicated by the fact that Mr. Kotzè has recommended that the gold law be changed so as to make tenders more inviting.

Mr. Kotzè was not only a witness before the Special Committee but he issued a report which indeed was the occasion for the formation of the committee, and which dealt at length with the situation.* Few blue books issued in recent years contain as much of interest and value to those concerned with gold mining. While the report is modestly styled a 'Memorandum on the Far East Rand,' it is really a technical monograph of a high order of excellence. No more concise and exact report can be found upon mining conditions in the area. In his recommendations furthermore Mr. Kotzè shows a welcome disposition to look at matters in the largest possible way and not to be misled from the main purpose, the opening of the mines on the best possible basis for all concerned, even when conceivably some slight but doubtful advantage could be obtained for his client, in this case the government. As he stated to the Committee: "If it is possible one should try and have a satisfied lessee. I think further that if the impression is allowed to exist that, should any difficulty arise in connection with future leases, the government is going to be absolutely rigid and will refuse to consider any point brought up which might improve the conditions under which the leases are issued, it will have an unfavourable effect upon the provision of capital for the further development of the Far East Rand. I think if a lessee comes along in the future with a reasonable request and he knows that such reasonable request will be considered by Parliament or the government, then we are more likely to get money than if he knows that it will be met with a flat refusal." It is because Mr. Kotzè's memorandum is written in this spirit, quite as much as because of the fulness and accuracy of the technical data included, that we commend it to our readers. We are glad also to record that the report and the testimony offered to the Select Committee led them to recommend substantial changes in the gold law designed to remove its more obvious defects.

It is a matter of regret that Parliament adjourned without taking action on the report of the committee.

The principal changes proposed were:

1. Provision of a responsible Mining Leases Board to receive tenders for leases on the mining rights of areas and advise the government with regard to them.

2. Provision for indirectly enlarging the mynpact by allowing a landowner when selecting his area, in cases where the mynpact because of depth to the reef or other natural causes is not large enough to make a "workable proposition," to tender for a lease upon a sufficient adjacent supplementary area.

3. Provision that the initiative as regards leases might be taken by the proposer, who might at any time make an offer for any open territory and who would be no longer tied down to such specific areas as the government may offer at a particular time.

4. Provision that the whole capital need not be provided in advance, but only as needed.

5. Provision is made for amortization of capital out of the super tax which it is anticipated will be offered for leases over any agreed term of years. This opens the way to the eminently fair system under which a lessee may recover his entire capital from profits before the government participates other than through the payment of ordinary taxes. It is a marked step toward what we believe to be the ideal system of taxing mines and it is a pleasure to see the Union setting so good an example to other governments.

All of the changes noted above were badly needed, and collectively they should operate as a powerful stimulus to the opening of additional mines on the Far East Rand. Whether or not this result be actually or quickly achieved will depend materially upon the attitude of the new Board of Mining Leases in the administration of the law. It is definitely stated that the purpose is to afford each lessee a "workable mining proposition." Opinions will differ greatly as to what terms fulfil this requirement. The best available guide as to what is likely to be the official interpretation is given by Mr. Kotzè in his memorandum. Since the government mining engineer is to be a member of the new Board, it may be presumed that his opinion in this particular will at least be the starting point for consideration of new leases. Mr. Kotzè has taken as the basis of his estimates the assumption that by a "workable mining proposition is meant a mine returning annually over a period of 20 years, after paying its share of profits to the government, a dividend of at least 15% on the capital sunk, and also a further sum which, invested at 3% compound interest, will at the expiry of this period amount to the capital invested." He explains further that by "ac-

* For abstract of this report see p.p. 75-83.

crued capital" is meant "the amount spent on shaft sinking, equipment and advance development, plus interest at the rate of 6% up to the date of commencement of production," and that these assumptions necessitate a dividend of approximately $18\frac{3}{4}$% on the accrued capital when the life is 20 years.

These proposals mark a considerable departure from past practice. For one thing, the present gold law only allows for amortization of the actual capital invested without any allowance for accrued interest, neglecting the fact that the money is risked and is at work as truly before as after production begins. It is from this fact that the odd circumstance arises that Mr. Kotzè's estimates all show a higher allowance for sinking fund than for 'amortization.' An interesting side light on the expectations of the government is given by the further fact that Mr. Kotzè's estimates are predicated upon a contribution to the government equal to double the present profits tax.

At first glance these terms would seem to be sufficiently attractive to interest capital, but further study raises a doubt. It is generally recognized that to compensate for the risk involved gold-mining companies must pay more than a normal rate of interest. It is true that most people buy mining shares because they expect to sell them later at a higher price, and most promoters finance mining companies because they expect to receive without price shares which they may later sell at a premium. We are dealing here, however, not with shares but a proposed business and, one furthermore, where all promotion shares are rigidly excluded. The practical question is whether the terms are sufficiently good to tempt money in large amounts into mining on the Far East Rand, for it is in large amounts that the money will be needed. The majority of people have little idea of the real cost of money. They look at the Bank of England rate or call money in New York and say money is worth 2, 3, or 4% as the case may be. They fail to recognize that this is the rate for money under very especial conditions, namely, that it shall be immediately available on demand. When, too, one buys a bond or debenture, paying 6 or 7%, it is not generally recognized that before the 6 or 7% is paid a banker's commission has been paid, and probably back of that a promoter's profit. It is because money, necessarily or otherwise, passes through many hands before it gets from the investor to the business, that the apparent rate of interest is low. A keen student of such matters and an experienced financier estimated even in pre-war times that little money went out from London for investment in mines except on expectation of earning, directly or indirectly, at least 17%. A large and widely experienced American mining house sets it down as a rule for guidance of its officers that no business is good enough for the firm that does not show a prospective return of 20%. What the real profits are in other cases are not easily learned, but sufficient has perhaps been stated to indicate that the proposed 15%, which as I shall show later is really 8 to 10%, is no exceptional inducement to those who are accustomed to find money for gold mining enterprises, all the more since the rate of interest in other fields has been raised greatly by the war. It is the professed purpose of the government to make the terms such that gold mining may be reasonably profitable in and of itself, and so as to discourage any disposition to look to the share market for the profits of the enterprise regardless of the success of the mine as a mine. It is this effort to give the public a fair deal, as we understand it, that leads to the prohibition of promoter's shares and the requirement that a certain portion shall be offered at par in South Africa. It is doubtful whether any such provisions will entirely accomplish their purpose, but at least if this be the programme the government should not defeat its own purpose by offering in fact less than it seems to offer. This is in substance what is done.

It may be noted that under Mr. Kotzè's plan, the 15% is only to be allowed upon accrued capital and that up to the time the mine begins production only 6% is to be allowed. This is doubtless from analogy with the construction account when a railroad is built. The circumstances are not, however, the same. A railroad is a permanently profit-earning enterprise, and usually is built by a construction company which receives back all its money, both principal and interest, when the road is completed. When a mine is ready to produce its owners must wait for their money. Where railways are privately financed they are always most liberally watered with promoter's shares in fairly weird variety. None of these conditions obtain in the case under discussion. In fact, the period before the mine begins to produce is the period of maximum risk and, if there be any basis for discrimination, the 15% should be allowed during the construction period and the lower rate later. Actually, of course, the extra risk, which it is proposed to compensate by an extra rate of interest, is incurred from the first day and is never entirely absent until the capital has been amortized.

In the case of the Far East Rand, the matter is especially important because of the long period necessary to bring a mine into production. This is estimated at 3 to 7 years for mines working at 1000 to 4000 ft. in depth. In the case of the deeper mine, the preparatory period is equal to more than one-third of the productive period, a long time through which to ask that money be spent with only a deferred interest at 6%. That this is not an academic objection may be easily shown. Mr. Kotzè's estimate is that where the reef lies at a depth of 1000 ft., 756 claims are needed to constitute a workable proposition and that these may be estimated to yield 6,800,000 tons over 20 years after a preparatory period of 3 years. With a recovery of 27s. 6d. per ton, working costs of 19s. 3d., he makes the net return 15%. The actual return varies between 9 and 10%, depending upon the assumed rate of expenditure in the three years of construction. Similarly, for the 4000 ft. mine with a gross production of 20,000,000 tons and a preparatory period of 7 years, the actual net return is between 8 and 9% and not the proposed 15. Just how significant this is is shown by the fact that Mr. Kotzè, estimating for 5000 ft. mines even of an annual capacity of 1,200,000 and 1,500,000 tons, finds them unable to fulfil his theoretical conditions as they would yield but 10·8% and 12·2% on his own basis. The real return would be less. If it is admittedly unprofitable to open a 5000 ft. mine for a return of 10 to 12%, capital certainly ought not to be expected to open the shallower mines for a return of but 8 to 10%. These figures, we believe, demand readjustment. Fortunately, this is a matter which will lie wholly within the province of the Board of Mining Leases and, in full accord with the general purpose of the law, indeed to fulfil that purpose, they can and must grant terms better than Mr. Kotzè's minima.

The second critical factor in the proposed new leases is the area granted. Mr. Kotzè has already shown that the area now allowed as a mynpact is in most instances too small and provision is in the making at least for enlarging it. Since the purpose of the original mynpact was to reserve to the landowner a reasonable portion of his farm for mining, it would seem that a strong case exists for granting him, without extra charge and as a matter of right, whatever area is found under the special conditions existing, to be needed to make his mynpact a "workable mining proposition." Otherwise the State is in the position of giving with one hand and withholding with the other. This point, we urge, should be taken fully into account as applications for supplementary areas come before the new Board.

A larger question relates to what constitutes a workable area. Mr. Kotzè, basing his conclusions upon the admirable geological survey of the district executed by Dr. Mellor, and upon the results of mining and exploration so far conducted in the area, has set certain standards as to minimum areas for various depths to reef. There is danger that the public will think of these as maxima rather than minima and that pressure of public opinion will be against granting leases for areas in excess. In fact they are only proposed as minima, and it is doubtful whether indeed they are sufficiently large to be acceptable as such.

Dr. Mellor has pointed out that the characteristic occurrence of gold in the Far East Rand is in patches. There are areas where there is no conglomerate, but the quartzite roof rests direct on the slate floor. There are other areas where the conglomerate is present, but its gold content is too low to permit of profitable working. There are still other areas, fortunately, where the conglomerate is not only present but sufficiently rich to permit profitable mining. It is impossible to determine these areas from the surface and boring is at once too expensive and too uncertain in results, owing to the small size of the core in proportion to the area tested, and the prohibitive cost of drilling a sufficient number, to permit discrimination in advance of sinking and driving. The rich patches, fortunately, are sufficiently large to make good workable stopes, and in part of the field at least they are sufficiently numerous and lie sufficiently close together to form a basis for large scale mining. It is characteristic of the area, so far as tested, that the ore is either well above or well below the workable grade. The Springs, for example, reported at the end of 1915 a reserve of 1,125,000 tons of 10·4 dwt. ore with 1,147,000 of 1·8 dwt. At the Brakpan the year before the figures stood, 2,490,000 tons of 6·7 dwt. and 5,211,000 of 2·3 dwt. ore. Even within the limits of the ground sampled, therefore, there is a large concentration of the gold into certain particular patches. If it was not for this fact none of the area would be minable. The problem in exploration is to find a sufficient number of these patches sufficiently near together to assure profit from mining. The total area as yet explored is only a small portion of the entire area of the field, though it is impossible to give any exact figure. It cannot even be asserted that the area explored represents a fair sample of the field, though there are many excellent reasons for thinking that it does approximate such a sample. The great distances that separate the mines, measured as they are in miles, the extent of the workings in the various properties measured again in miles, and the general agreement indicates that one may accept the results obtained with some confidence as a basis for further exploration. Taking past experience as a guide, the practical problem is to determine the size of an area such that within its borders one may be reasonably sure to find enough ore to redeem the capital invested and pay a profit on the enterprise. This is manifestly not to be done merely by determining the percentage of profitable to unprofitable ground as a whole and then assuming that this average percentage will be found under each block. As we have already suggested, if this assumption had corresponded with the facts of the case probably none of the ground could be mined. It is because there are areas that can safely be cast aside as not warranting further development after driving through them a few main passages, that it becomes possible to mine the remaining ground at a profit. The ratio of profitable to unprofitable ground so far as known varies from 15 to 85%. Mr. Kotzè has taken 40% as a conservative average and with this we have no disposition to quarrel, but the critical factor is what is the size of the unprofitable areas? Clearly the minimum area that will afford a safe basis for mining is one that will extend somewhat beyond the limits of any such barren or virtually barren area. In the future, as mining and exploration continues, it will become possible to forecast with some accuracy the probable occurrence or non-occurrence of a big area of unprofitable ground at any particular point. For the present too little is known to give much basis for specific forecasts, and we must fall back upon certain general facts. Remembering that all the companies still have considerable areas to explore, there are certain cautionary statements that seem warranted. In his testimony before the Select Committee already mentioned, Mr. Wallers cited four properties upon which considerable sums had been expended, ranging from £200,000 to £250,000, without finding any sufficient body of ore to warrant mining. These are the Van Dyk, Rand Collieries, Rand Klip, and Cloverfield. The Van Dyk and Rand Collieries are contiguous properties and together they include 1701 claims. In the Van Dyk 24,352 feet of development other than shaft sinking has been done and 18,039 feet sampled showing an average of 5·63 dwt. over 30 inches. In the Rand Collieries persistent work has only resulted in development of 374,200 tons averaging 5·375 dwt. over 42 inches. Here are two properties upon which over £1,000,000 has been expended without satisfactory result. Assuming that only half their area has been explored it still remains true that a low-grade or barren body of reef extending over approximately 1000 claims has been shown to be present. It is worth noting that in each case approximately as much work was done underground as at the Springs mine, which in contrast has developed an excellent body of workable ore. It is also to be noted that both properties are much nearer profitable mines than is Springs. It is true, however, that both mines lie to the dip of a part of the outcrop that has proved disappointing. Far to the east of these mines and beyond the group of famous producers including the Van Ryn, the Modders and their deeps, are the Rand Klip and the Cloverfield. On neither has as much work been done as on the Van Dyk and Rand Collieries, but so far as it goes both have proved disappointments. The Rand Klip has done 6117 ft. of development on three levels, and in this only 640 ft. showed 11·2 dwt. over 24 inches, though in all, 4395 ft. sampled showed 4·62 dwt. over 21 inches. In the Cloverfield of 7450 ft. of development only 5975 was sampled, and only 1505 ft. was found to average 15·9 dwt. over 13·1 inches. It is worth recording, too, that boreholes put down by the government between Rand Klip and Modderfontein B showed ore of about 5 dwt. value. Here apparently is another extensive area, covering approximately 1000 claims, which seems likely to prove unprofitable.

Both of the areas so far discussed lie at one or the other side of the belt or zone of profitable mines now being opened in a southeast trending direction from the Modders to the Nigel. It is not certain as yet that this zonal arrangement is significant, but assuming that it may be, inquiry may be directed to the question of what areas have been found to be unprofitable in the zone itself. Here the specific information has not been published but it is an open secret that the Geduld started with the expectation of opening several mines and has concentrated, after a considerable amount of exploratory work, on one. Government Areas was planned for two mines and four shafts were actually sunk to the reef. A considerable amount of driving has been done from each and here again it is no secret that experience has forced concentration of effort on a limited part of the area falling within the outer points reached by thc exploratory drifts. Both Geduld and Government Areas have large extents of territory wholly unexplored, but it is perhaps fair to say that the work so far done indicates that here in the heart of the productive part of the Far East Rand there are patches of as much as 400 claims, roughly one square mile, from which little can be anticipated, and that these areas may be even larger.

Unsatisfactory and incomplete as these data are they are the best available and they form the basis upon which exploration and development must be planned until such a time as better data become available. Mr. Kotzè has suggested as minima for mines working at 3000 and 4000 ft., and calling respectively for capital expenditure of £1,151,000 and £1,975,000, areas of 1445 and 2445 claims. If, however, the investor must face the possibility that 400 to 1000 of these claims will prove nothing but a source of expense, these minima become of merely academic significance. It is impossible to be sure that in each individual allotment 40% of the ground will prove profitable and a larger area should be granted in order to increase the security of the investor.

There is no reasonable objection to granting large areas provided the Board is satisfied as to the ability of the lessee to furnish capital for development when and as needed. What is wanted is to get the ground explored and the mines producing. While every precaution should be taken to prevent tying up lands for speculative purposes, and the powers of the proposed Board are ample for this purpose, it makes no real difference to the public which company mines under a particular acreage, provided only that the mining be done. The indirect benefits to the country are so large and the direct returns to the government so important that the main thing is to get the gold out of the ground and set it to work. According to the figures collected by the Dominions Royal Commission the Rand mines contribute annually to the government £12,000,000 and expend £8,000,000 in addition for the one item of white labour. This latter sum is just equal to the average amount received by the shareholders in the form of dividends. Clearly both the government and the voters of the Union have more concern in seeing that gold mining does not languish than have the shareholders of the various companies.

The Union of South Africa holds, in a certain sense in trust for the world, a great resource. The longer the gold lies unused in the ground the greater the loss, since a year's interest once lost can never be regained. It is to the interest of South Africa, as it is to that of the world in general, that the gold should be mined and set to work at the maximum rate of speed consistent with maintaining satisfactory social conditions. That brings up another and a large problem which cannot be adequately discussed at this place or time. We may, however, record our conviction that it is to the general public interest that the output of gold on the Rand should at least be maintained at its present standard as long as may be possible. To do this requires the opening of more Far East Rand mines.

Australian Copper Policy.

The Commission which has been studying the metal situation in Australia has made its report and recommendations. It is found that while it is desirable to refine in Australia the copper produced there, two-thirds of such copper will continue to be exported unless the use of copper goods locally be increased. To impose a duty upon all copper goods would be imprudent for the present. The following recommendations are made:

1. That the following bounties be granted:
   (*a*) £3 per ton on all copper or brass plates, sheets and bars, and
   (*b*) £5 per ton on all copper or brass pipes, tubes and wire

manufactured in Australia from copper produced and refined within the Commonwealth. These bounties should provide a fair stimulus to manufacturers to initiate the industry, and the Commission recommends that they be continued for a period of not less than five years, at the end of which the bounties could be reviewed, as full information as to costs of production would then be available.

2. Covered and insulated cable and wire: In the absence of definite information as to the costs of production and the practicability of locally manufacturing these lines, the Commission is unable to make any recommendation.

3. The Commission notes that the Government has, by proclamation issued in terms of powers conferred by the Customs Act, placed an embargo on the export of metals and minerals, which includes copper ores, matte, and blister. This action will, while such order lasts, insure that practically all copper will be refined in Australia.

In order to prevent the undue inflation of the cost of refining to be paid by mining companies, the Commission would suggest that a supervision of the prices charged for treatment by the refining companies should be instituted. To prohibit permanently the export of copper ores, matte, and blister without some such supervision will give the refining companies an undue monopoly which may react on the copper mining industry.

SPECIAL CORRESPONDENCE

JOHANNESBURG.

Deep Development.—The usual plethora of shareholders' meetings passed off this year with less enthusiasm than usual, but some interesting features were dealt with in the speeches from the chair. For some time past the position of affairs underground at the East Rand Proprietary mines has attracted attention, but it was never anticipated that the ground in the neighbourhood of the water dike to the west of the Angelo Deep property would turn out so badly. There has been little hope of finding profitable ground around the Angelo Deep and Hercules shafts and the salvation of the property lies, if anywhere, in the huge area lying unproved to the south of the deep level shafts. Few efforts to prove this ground have been made since it was merged into the East Rand Proprietary mines, as the western area along the plane of No. 27 level was anticipated to make up for the low grade of the ore found east of the Angelo Deep shaft. The western area having proved a failure, it has become necessary to prove the ground lying to the dip of the shafts much quicker than seems possible by continuing the main incline shafts in close proximity to the reef. To attain this object a rather novel experiment for the Rand is to be tried. Two cross-cuts are to be started off in a southerly direction to the south from each of the Angelo Deep shafts at a vertical depth from the surface of 4000 ft. and in such a direction that they will meet after being driven a distance of 4000 ft. At the point of intersection it is proposed to put down a vertical shaft to the underlying main reef series which is expected to be found at at a depth of 2000 ft., making the total depth from the surface some 6000 ft. This is a large undertaking. It is anticipated to cost £200,000 and to be completed in about four years. The prospects of this ultra-deep level ground have not been held to be good, but as a matter of fact there is nothing upon which to base any opinion.

A similar bold step is to be taken by the Crown Mines, where a similar huge unproved area lies to the south of what is known as the South Rand dike, where no less than 1278 claims remain to be proved. The Crown Mines have taken time by the forelock and already sunk No. 5 shaft no less than 1250 ft. below the intersection of the Main Reef series, which will permit opening the ground lying to the south of the dike. It will be some time before this area must be worked, but the magnitude of the operation will be understood when it is known that £1,500,000 is to be spent on this deep ground, spread over a period of about fourteen years. Despite the somewhat disappointing results obtained since the amalgamation of the various mines now forming the Crown Mines and the huge expenditure made with the object of lowering the working costs, the board shows considerable enterprise in tackling this deep ground. The East Rand Proprietary from putting off similar advance prospecting finds itself in a tight corner.

Far East Rand.—Some disappointment has been expressed at the action of the Government in postponing the consideration of the proposed legislation in connection with the leasing of the Far East Rand government areas on the ground that it is inexpedient to raise party feeling at this time. The agitation started locally that the present Government should open these areas by means of state mines is not taken seriously here, but it is considered to be a mistake on the part of the Government to delay legislation at a time when so much attention has been attracted to the area. That the attraction of the ground lies more in its speculative than established value is proved by the class of investors prepared to put in tenders providing the Government can place the mining legislation on a satisfactory basis. Much pleasure has been expressed that the Consolidated Mines Selection has shown a disposition to take up larger areas of the Far East Rand but it is scarcely to be expected that the brilliant results obtained at Brakpan and Springs can be indefinitely repeated. Few but those controlling the Brakpan Mines would have risked the sinking of two such deep shafts in the face of such unsatisfactory borehole results, as at that time nothing was known of the peculiar manner in which the reef occurred in this section of the Rand although the Nigel Mine, New Modder and Van Ryn had been at work over 20 years. Even the Transvaal Coal Trust which had acquired the freehold of the Brakpan and Springs properties solely on account of their coal, was not then prepared to undertake the cost of preliminary boring where similar boring operations on the neighbouring Apex property over a period of 20 years had not been a conspicuous success. Nor were the results obtained on the Boksby, East Rand Extension, Van Dyk, Rand Collieries and other properties likely to attract new capital. It is beginning to be recognized that nothing short of shaft sinking and driving along the reef will be able to establish fully the value of the Far East Rand properties and where a new lease has to be tendered for to work at depths of from 4000 to 5000 ft. only those who have approached the property underground will probably display sufficient enterprise to put in a tender. The Consolidated Mines Selection having already obtained a good footing in the Far East Rand should be in the best position for expansion. Unless, however, the risks are reduced to a minimum by the Government, even successful lessees have no great encouragement to tender.

SAN FRANCISCO.

MEXICO continues to hold attention. It is now generally accepted that war between Mexico and the United States has been averted. The show of force made by the Washington government in summoning the National Guard to patrol the border had the effect of strengthening the *de facto* government of Señor Carranza, because, with war impending, many recalcitrant Mexicans rallied round what leadership they had, which, bad as it is, was the best available. The dispatch of the State militia to Texas from all parts of the country was prompt and impressive. The quick mobolizing of 200,000 active and adventurous young men, most of whom had received training, showed that, even for border warfare, volunteers are not wanting. Many engineers, mining and otherwise, have left their work to go into military training-camps; for instance, Robert Marsh, jr., general mine superintendent for the Nevada Consolidated Copper Co., Percy Barbour, managing-editor for the *Engineering & Mining Journal*, etc. In most cases engineers secure the rank of lieutenant after a little training. Now that war has been averted, American mining companies are sending their staffs back into Mexico. The two principal copper mines, the Green-Cananea and the Nacozari, both in Sonora, are being re-opened after a few weeks of curtailed operations. Gold and silver mines in Durango, Sinaloa, and Zacatecas are resuming operations. These three states have the advantage of access from the Pacific-coast port of Mazatlan, which is relatively quiet and peaceful. Steamship service from San Francisco to Mazatlan makes the passage much safer than an all-rail route through the disturbed border territory. Mazatlan is just east of the southern tip of the peninsula of lower California. An American mine superintendent recently in San Francisco, who has returned to a mine in Durango, taking his wife, reports that while occasional small groups of bandits ride into town, they come and go with little trouble and bother no one. That all Mexico is not in the same miserable condition as the border states and Mexico City, is indicated by the recent large increase in Mexico's foreign trade. During the ten months ending April 30, Mexico's trade with the United States was $119,080,000 of which $79,023,000 was our imports and the remainder our exports. This compares with a total foreign trade for Mexico of $88,288,000 in the previous year, a gain of nearly 40%.

Metal prices have declined, copper to 25 cents, zinc to 9 cents, lead to 6½ cents, antimony to 12 cents, while tungsten ore is bought at about $25 per unit. These recisions have caused a little uneasiness, and have been variously interpreted as presaging the end of the war in Europe. Though temporary dulness may mar the metal market, and lower figures prevail, it is still evident that the present prices are very profitable and production continues on a large scale. It is generally believed that copper will continue above 20 cents for several years, as Germany's demand when peace is declared should make up for the decrease among the Entente Allies. Zinc, it is admitted, is doomed to lower figures, because this country's rate of production has been practically doubled in two years. The United States has taken the place of Germany and Belgium as a zinc smelter during the hostilities in Europe, but this condition cannot continue. Money has been lost in this country in antimony, it is reported, and the boom in tungsten was probably a little overdone.

Production of copper, zinc, and lead remains at stupendous figures. The capacity of the refineries has been exceeded by the copper ingots and bars received, and many of the smelters have more ore on hand than they can manage. While the United States produced 694,000 tons of copper in 1915, a large gain over the 575,000 tons of 1914, it is likely that the output in 1916 will be fully 750,000 tons. Arizona alone intends to produce 300,000 tons compared with 216,000 tons last year. In zinc mining, the Butte & Superior mine in Montana is producing at the rate of 95,000 tons per annum, equivalent to 12% of the country's output. This is more metal than is produced at the Utah copper mine, the world's greatest copper producer at this time. While the country's output of zinc from domestic ore last year was 458,135 tons, compared with 343,418 tons in 1914, the production this year is likely to be over 600,000 tons.

The New Cornelia Copper Co. of Ajo, Arizona, a subsidiary of the Calumet & Arizona Mining Co. of Bisbee, is hurrying preparations for a production of 16,000 tons of copper per annum. Of the estimated ore available, 11,950,000 tons is oxidized and will be treated by a leaching process with sulphuric acid furnished by the Calumet & Arizona smelter at Douglas. Sulphide ore amounts to 28,303,600 tons and will be treated by the flotation process. The total orebody is estimated at 40,258,000 tons, of 1·51% copper. This mine is in one of the most arid regions of Arizona, and a shaft 650 ft. deep has been sunk nine miles away to furnish water. The ore is in a series of hills with no overburden to impede open-cut mining. The oxidized ore will be crushed only to 4-mesh for leaching, which will take eight days in lead-lined tanks by upward circulation advancing from tank to tank, the oldest charge getting the strongest acid, about 3%. Besides copper, the acid dissolves iron and alumina; the ferric iron is converted to ferrous iron by reducing with sulphur dioxide. Copper is deposited from the solution electrolytically. The thorough tests made in advance indicate a recovery of 80% of the copper in the ore by this method.

WESTERN AUSTRALIA.

West Australian Output. — The annual report of the Department of Mines for 1915, just published, shows that the mineral output of the State for the year was worth £5,478,149, being £55,841 less than that for the previous year.

The value of the gold yield was £5,140,228. Dividends paid by mining companies amounted to £792,317, being a decrease of £7075 in comparison with 1914. The yield shows a decrease of 22,865 oz., while the average value per ton of ore for the whole State has risen from 37·81 shillings to 38·41 shillings per ton. This rise is due to the economic necessity of the big mines increasing their grade to meet the higher cost per ton. This in turn is caused by the rise in the price of explosives, steel, cyanide, mill spares, and general stores. One pleasing feature is the fact that, although many of the best of our miners have responded to Britain's call, and are now on active service, the tonnage raised and treated per man has increased from 231 to 238.

The tonnage mined from the Coolgardie (including Kalgoorlie) and East Murchison goldfields shows a decrease for the year, but Mt. Margaret, Broad Arrow, Yilgarn, and Yalgoo goldfields show an improvement. The mines at Westonia (Yilgarn), Lancefield (Mt. Margaret), and Ora Banda (Broad Arrow) are mainly responsible for this.

In the Yalgoo goldfield, a new centre has been opened at Warriedar, where an English company is working several of the most promising properties under a development option. The result of this work, both from a mining and metallurgical point of view, is being watched with considerable interest. The decantation process is being used in the slime treatment. During the year several lots of high-grade bismuth, scheelite, and wolfram have been obtained from this field and exported.

The quantity of tin exported was 429 tons, valued at £21,431, of which the Greenbushes district produced 247 tons, and the Pilbarra field 79 tons. The value of the copper exported was £91,169, of which the principal producing centres were Phillips River, West Pilbarra, Ashburton, and Peak Hill (Ilgarary). Only high-grade ore (25 to 40%) is sent from Ilgarary as it has to be carted by camel team 200 miles to Meekatharra, and thence railed 636 miles to Perth. In lead and silver-lead ores 2883 tons valued at £39,032 were exported in 1915. Owing to the greater demand for lead, the Fremantle Trading Company has recently resumed smelting, and treats the lead concentrate from its Baddera and Narra Tarra mines at Northampton. Several smaller mines in that district are now at work, and are sending high-grade ore and concentrate to Fremantle. From the six mines at the Collie coalfield, 286,666 tons of coal were mined, valued at £137,859. Deposits of graphite exist at Kendenup, which is situated about 40 miles from Albany. The quality is reported to be satisfactory, and a lot has been sent to London, for experimental purposes.

Wages at Kalgoorlie.—As the wages-agreements have terminated, a conference between the Chamber of Mines and the Miners' Unions has recently been held. The Chamber offered to increase the minimum wage of truckers and shovellers from 11s. 2d. to 11s. 8d. per day, and of surface labourers from 10s. 9d. to 11s. 3d., to married men or to single men having dependents. The Unions rejected this offer and asked that there should not be any differentiation between single and married men. The Chamber, however, declined to amend their offer, and the Unions are now discussing the question of applying to the Federal Arbitration Court for an award. As foreshadowed in a previous letter, there is not any talk of a strike, and it is to be hoped that there will not be any diminution of the output of gold at this time when every ounce is needed.

TORONTO.

PORCUPINE.—The initial report of the Hollinger Consolidated, covering the period from January 1 to June 16, shows the effect of the merger, under which the Hollinger became amalgamated with several other properties. This transaction automatically wiped out the surplus of the old company, and doubled the dividend payments, the new company's liability to the shareholders of the Acme, Millerton, and Canadian Mining & Finance companies being for an amount equal to the dividends paid to the Hollinger shareholders. The balance sheet shows profits of $1,261,900 and dividend payments of $1,440,000, leaving a deficit of $178,100. Working costs totalled $884,956, being $3·36 per ton. The mill, running 92·5% of the possible running time, treated 263,356 tons of ore of the average value of $8·80 per ton. Delays have occurred in obtaining equipment for the mill extension and the company has not yet been able to bring up the capacity of the plant to the anticipated tonnage of 1900 tons per day, but it is hoped before long to bring up the output to an amount sufficient to wipe out the deficit. The statement of the Dome Mines for June shows a production of $179,000 from the treatment of 36,700 tons of ore yielding an average of $4·88 per ton, at a working cost of $2·62 per ton. A long cross-cut is being driven at the 700 ft. level toward the Dome Extension to carry on the exploration of that property under option. Diamond drilling on the Dome Extension has been attended with favourable results, proving that the formations are identical with those of the Dome. Negotiations are on foot for a merger between the Vipond and the Huronian Belt Co., which controls the North Thompson property. Both companies could be worked from one central shaft which, with the contemplated enlargement of the Vipond mill, would considerably lower operating expenses. The Vipond is at present being operated at a loss. During the quarter ending June 30, $37,600 bullion was produced from a tonnage of 10,185 tons, being an average of $3·61 per ton, while the working costs were $4·45 per ton. Conditions are expected to improve with the milling of a better grade of ore from the 400 ft. level. The McIntyre has found an important orebody by diamond drilling at 900 ft., the vein being 22 ft. wide. The vein found at the depth of 1000 ft. on the McIntyre Extension is proving up well, with ore assaying $13 per ton. The McIntyre, McIntyre Extension, and Jupiter properties are being valued preliminary to amalgamation. The Newray has let contracts for 30,000 ft. of diamond drilling. The Dome Lake has cut a high-grade vein on the 300 ft. level. During June the Schumacher produced bullion worth $24,379, being $5·94 per ton milled; operating costs were $3·80 per ton and net profits $8793.

KIRKLAND LAKE.—The final survey is being made for the transmission line of the Northern Ontario Power Co. from Cobalt. Its completion is promised this fall. The Teck-Hughes mill has been completed and is ready to start as soon as power is obtainable. The Lake Shore has obtained rich ore from a shoot on the 300 ft. level. The mine has been closed for the erection of additional equipment. The Tough Oakes is treating about 120 tons per day and has 21 drills running in the mine. Owing to lack of power only one of the compressors can at present be operated. The Wright-Hargraves property which has two veins showing visible gold on the surface is being opened up.

COBALT.—The Nipissing is steadily increasing its production. During June the company mined ore of an estimated value of $294,669, and shipped bullion from Nipissing and custom ores of an estimated net value of $193,405. Lower levels for exploration at three different points were opened. The Crown Reserve made a good find on the 700 ft. level, where a vein of milling ore, with patches of high-grade, was found. The fact that this is in the Keewatin and several hundred feet below the level at which any ore had previously been found on the property is regarded as encouraging. The Beaver having reached the lower level contact between the diabase and Keewatin is crosscutting at 1600 ft. The Mining Corporation of Canada has closed the Cobalt Lake mill in pursuance of a policy of concentration, and the ore from the Cobalt Lake mine will be treated at the mill of the Cobalt Reduction Co. The Kerr Lake production for June was 237,942 oz. The Timiskaming has opened a rich vein 14 in. wide on the 500 ft. level, which is stated to contain upwards of 8000 oz. of silver to the ton.

PERSONAL.

GEORGE BEATTY is acting manager of the Government Gold Mining Areas (Modderfontein) mine.

CHARLES W. BOISE is expected in London from Spain.

R. GILMAN BROWN and D. P. MITCHELL have returned from Russia.

H. KENYON BURCH has completed his work on the design and construction of the Inspiration plant and is taking an extended vacation. His letters should be addressed to the Sierra Madre Club, Los Angeles, California.

DONALD CLARK is advising the South Australian government with regard to technical education problems.

A. H. CLEMENTS has joined the staff of the New York Engineering Co. and will erect the Chiksan dredge.

A. H. COLLIER has been appointed to a seat on the board of the Ivanhoe Gold Corporation. He was a large shareholder in the original Australian company.

MAJOR L. J. COULTER, of the Australian forces, is recovering satisfactorily from wounds received in France.

H. J. DANIEL is in charge of dredging and sliming operations at Hokitika, New Zealand, for the Rimu Options company of Sydney.

CAPTAIN J. S. DAVIDSON, a director of the company making the Sirocco fan, has been killed in action in France.

W. R. DEGENHART has returned to London.

CLEMENT DIXON has been elected president of the Rhodesian Scientific Society. He is already a member of the executive committees of the Rhodesian Chamber of Mines, the Munitions and Resources committee, and a town councillor of Bulawayo.

JAMES T. DIXON has gone to Colombia.

FRANCIS DRAKE is at Birmingham on munition work.

DAVID DRAPER is leaving for Brazil.

A. E. DRUCKER expects to leave London on August 18 for New York, where he proposes to open an office as consulting engineer and metallurgist.

W. H. EPLETT is home from Perak, and is staying in Cornwall.

F. LYNWOOD GARRISON has gone to Brazil.

H. W. GEPP was in California recently.

F. H. HAMILTON is leaving for Canada this month.

H. R. HARPER has been elected president of the Electrical Association of Australia.

RENE E. HAZARD, formerly manager of the Sambenigno mines, Colombia, joined the French army in February, and is now acting as interpreter with the British Expeditionary Force at the Somme front.

GEO. T. HOLLOWAY has returned from Norway, and will leave for Canada the latter part of the month.

W. L. HONNOLD has been in France in connection with the work of the Commission for Relief in Belgium.

R. H. JEFFREY has been appointed manager of the Mazapil copper mine, Mexico.

J. T. KEATING is here from the Argentine.

NEWTON B. KNOX is back in London.

G. G. S. LINDSEY has returned to Toronto from China where he has been for the past year.

W. H. LOVELETT has left for California, returning from Congo Belgè.

A. H. MORGAN has resigned the position of chief engineer for the Burma Ruby Mines company, after 27 years' service. He is succeeded by BERNARD RANCE.

P. G. MORGAN, Director of the Geological Survey of New Zealand, has been appointed Under Secretary for Mines.

H. A. B. MOTHERWELL has left Gourock, Glasgow, for Clifton, Arizona, to take up an appointment with the Arizona Copper company.

JAMES PARK has left for West Africa, to take the position of acting manager of the Wallis Company's properties.

CAPTAIN R. G. PEARSON is back in England on the conclusion of his services in South-West Africa.

LIEUT. CLAUDE PERRY, one of the young mining men who left his professional work to fight for his country, has died from the effects of wounds received in France. He was well known at Cobalt, in Nevada, and in Congo Belgè where he had been a member of the staff of Forminière.

BERNARD PRICE is the new president of the South African Institute of Engineers.

C. W. PURINGTON is leaving shortly for New York.

CECIL RAE has obtained a commission in the Indian Army with the 3rd Sappers & Miners, at Kirkee.

CAPT. F. B. REECE, who has been in hospital with trench fever, has been discharged and is resting at home before returning to the front.

GEORGE RICHARDSON has resigned the chairmanship of the Weardale Lead Co., owing to ill-health. He held the position continuously since the formation of the company in 1883. He is succeeded by A. F. ERICSSON.

J. S. RICHARDSON has been appointed manager of the mine of the Pilgrim's Rest Consolidated Gold Fields company in the Transvaal.

H. M. RIDGE has been in Paris.

WILLIAM RUSSELL, European manager for the Dorr Co., has returned from Russia.

FRED SEARLES sailed from San Francisco on August 6 for China and the Far East.

J. H. SKILTON, for 18 years with John Taylor & Sons, and lately manager for the Lucy Manufacturing Co., has commenced practice as petroleum engineer and equipment contractor at Fulwood House, High Holborn, London.

HOWARD D. SMITH has been in Paris and is now in London.

LIEUTENANT ARTHUR P. SMITH, of the 1st Australian Tunnelling Corps, was killed in France on June 29. Before he joined the army, he was manager of the Sydney office of the Ingersoll-Rand company.

NORMAN STINES left London for Russia on July 22.

GRIFFITH TAYLOR has received the degree of DSc. of Sydney University for his thesis on Antarctic geology.

G. GORDON THOMAS left England for Naraguta, Nigeria, on August 1.

BEVILL TINWORTH, of Ballarat, is on the staff of the Burma Mines.

J. B. TYRRELL is in British Columbia.

LESLIE URQUHART has returned from Russia.

EDWARD WALKER has gone to the Isle of Wight on vacation.

J. LEWIS WALTON left England for Northern Nigeria on July 25.

E. H. WATSON has left for Siberia.

LIEUTENANT C. P. WATSON has been killed in action at the Somme front. He was formerly on the staff of the Simmer & Jack.

L. J. WINTON, formerly with the Great Cobar, has been appointed an Inspector of Mines for South Australia.

HARTLEY WITHERS is the new Editor of the *Economist*.

METAL MARKETS

COPPER.—The decline in standard continued during the earlier part of the month until cash metal was sold for £85 and three months for £84 on July 10. The market, after a short period of steadiness, then rapidly improved until prices were marked at £111 cash and £110 three months. Transactions naturally are restricted, but even so, such a rise indicates a substantial change in sentiment and probably considerable covering business. Electrolytic copper, which had declined to £124–£120, has now risen again to £127–£123 and in America from 24c.–25c. to 25½c.–27c. Business in refined has been fairly active. In rough copper there has arisen a heavy demand for sulphate-making and suitable brands are finding a ready sale both here and in Italy. Forward business, however, is neglected, the demand being confined to near-by delivery. According to American advices the Allied governments are again in negotiation with the American producers regarding the purchase of a metal to follow existing contracts. The cheap secondhand offerings from America have disappeared and a much firmer tone is reported from there. There is an extraordinary shortage of good class brands in warehouse, the stocks chiefly being represented by furnace material. Markets do not close at the best and in fact a reaction is due after the rapid rise.

As illustrating the scale of production at American mines, it may be mentioned that in May the four properties of the Jackling group produced 36,311,000 lb. copper. In detail the figures were: Utah copper, 15,950,215 lb.; Chino, 6,359,294; Ray, 6,278,611; Nevada Consolidated, 7,723,148. All these properties are worked by steam-shovel save the Ray.

Average prices of cash standard copper: July 1916, £95. 0d. 9d.; June 1916, £112. 17s. 9d.; July 1915, £76. 1s. 11d.

TIN.—The market in tin has been disappointing. Prices have repeatedly shown signs of improving only to relapse on the following market. Trading has been light and the market still lacks any sustained support from the large dealers. American demand has been unexpectedly small, the deliveries for the month amounting to no more than 4567 tons, while supplies from the Straits amounted to 5410 tons, but it is important to notice that supplies from the Banca and Billiton were only 435 tons. France, Italy and Russia have placed fair sized orders, but home consumption has been affected by the reduction of the number of mills operating and by the temporary closing of others for stocktaking and repairs. About 60% of the English mills are operating. American orders for 1917 are still to be placed and appear to have been postponed. Prices have fluctuated between £176–£161. 10s., but the close of the month gives no clear indication of the future. Bolivian tin-ore shipments for the first six months of 1916 are given as 9700 tons, of which 7168 came to Great Britain and 2455 went to America. In the same period of last year 11,381 tons came to Great Britain and 86 tons went to New York.

Average prices of cash standard tin: July 1916, £168. 9s. 6d.; June 1916, £179. 11s. 3d.; July 1915, £167. 5s. 11d.

SPELTER.—Prices here suffered a severe relapse. The official quotation stood at £61–£53 on the 1st of the month and a week later stood at £44–£41. At the lower level a good business developed with consumers and the prices gradually rose only to decline again to the end of the month when the official prices stood at £47–£42. America seems to be accumulating stocks and buyers on this side are shy, especially for forward delivery. Spot metal has been selling for good premiums. Production has at last overtaken consumption.

Average prices of good ordinary brands: July 1910, £48.7s. 6d.; June 1916, £63.16s. 4d.; July 1915, £97. 5s.

LEAD.—The prices realised have been improving and the official closing price is £28. 10s. to £28. The market demand still continues light but the shipments available for sale are barely enough to keep that demand supplied. The American price has meanwhile dropped to 6c. Some good prices are being obtained in Italy but the shipping difficulties are considerable. Similar difficulties are being experienced in shipping from Spain to this country and contracts are somewhat in arrear in spite of higher freights being offered.

Average price of good soft pig lead: July 1916, £27. 8s. 11d.; June 1916, £30. 14s.; July 1915, £24 12s. 3d.

ANTIMONY.—Quotations are nominal and there is for the present virtually no sale. The government price is £95 per ton for English, sold to munition makers only; Chinese crude is at £42½. Sales have been made in New York at 14½c., equivalent at present exchange rates to about £65. The Chinese made considerable money out of the metal while prices were high, but the depression now is general.

QUICKSILVER.—This metal is also out of demand, local prices being steady at about £17½. Recent American quotations are $80 per flask, which is still high for that market, but much below quotes of some months since. It is now known that little was sold at the prices then quoted. Ordinarily the United States neither exports nor imports quicksilver in any quantity. The war reduced the amount available in the markets of the Allies, as it shut off the Hungarian mines. At the same time embargoes prevented shipments to New York, while the manufacture of large quantities of munitions called for corresponding amounts of mercury for making fulminate. More than the usual amount was also called for for medicine. In the face of these conditions quotations rose to unheard of figures in San Francisco and production and resale was promoted. Imports being finally permitted, the price fell until now it has reached a point where the Americans are talking about exports to Europe. In pre-war years the American price was about $40 per flask (70 lb.) and the London price £7 to £10.

ALUMINIUM.—There is little trading in this metal, the government keeping its grip on the situation. Sales are at £155 to consumers only. In the United States demand is active and recent New York quotations were 60c. per pound, equal to about £280 London. The United States is importing this metal at an increasing rate, the figures for May 1916 and May 1915 being 1,391,575 and 418,708 lb. respectively.

BISMUTH.—Johnson, Matthey & Co. act as government agents in the control of this metal. Outside quotations are 11s. per pound. While there is little direct information, its use has presumably been increased by the war, both for medicinal purposes and for making low temperature fuses used in some forms of ammunition. An increased supply has been found in the rejects from magnetic concentration of tungsten ores.

CADMIUM.—This is quoted at 7½ to 8s. and the market is good. The *Engineering and Mining Journal* quotes a New York price of $1·30 to $1·50 per lb. at the end of July.

PLATINUM.—The official price remains 190s. per oz. in the United Kingdom. In the United States prices have dropped a little and in the latter part of July sales were at $60 to $62 per oz. A decree has been issued by the Cortez reserving from public search for two years the Ronda deposits, Province of Malaga, Spain. It is proposed to investigate the deposits at government expense and then work or lease them as may seem best.

NICKEL.—Prices of this metal remain unchanged, quotations in London being £225 f.o.b. for 98·99% guaranteed. In New York the price is 45 to 50c. per lb. with 5c. premium for electrolytic. Arrangements are being made to increase production and to refine in Canada as discussed in our Review pages.

IRON.—No change in official prices has been made and the market is inactive though there is insistent demand for war work. A little Cleveland iron is reported going to France at 97½s. per ton. There is considerable inquiry for home consumption but little is available for early delivery and pressure is steady to reduce to a minimum the private work.

MANGANESE.—Metallic, 90 to 95%, carbonless, at Sheffield, 4s. per lb. Manganese ore market is dull. Indian ore is reported offered at Atlantic ports U.S.A. at 70 to 75c. per unit, and Brazilian held at 40c. at Brazilian ports. A report recently issued by the United States Geological Survey points out how greatly war conditions stimulated domestic production in 1915. Russian ores being entirely cut off and Indian imports restricted, local mines long idle were brought into production. In all 9709 tons of manganese ores, four times the production of 1914, and 801,290 tons of manganiferous ores were mined and used. In the main, however, the American market was supplied by Brazil, which sent to the United States 268,786 tons in 1915 and 113,924 in 1914 as against 70,200 in 1913. Cuba is also being developed, but how much of this trade, based as it is on low-grade ore, will stand against competition when ore moves again freely from India and Russia is uncertain.

MOLYBDENUM. — Government control continues with the price of 90% MoS_2 at 105s. per unit. Ferromolybdenum of 70 to 80% is 15½s. per pound. There are few buyers of this metal and no general market. From time to time individual users supply themselves for six months at a time with the usual result of an upset market. The high price per ton does not encourage stocking by regular dealers.

TUNGSTEN.—The government price for 70% WO_3 is 55s. per unit. The American market has broken, but sales in New York are still at $25 to $27 per ton and France is reported to be offering $20. Ferrotungsten, of 75 to 80%, is quoted at 6½ to 7s. per pound in the United Kingdom. The metal powder, 96 to 98%, is quoted at Sheffield at 6½d. per pound.

TITANIUM.—Ferro-titanium, 15 to 18%, 5 to 8% carbon, 6½d. per lb.; 23 to 25% Ti, carbon free, 1s. 5d. per lb.

VANADIUM.—Ferro-vanadium stands at 14½s. to 15 per lb. of vanadium contained.

COBALT.—Metal 96 to 98% pure, 7½d. per lb.

CHROMIUM.—Metallic chromium, 92 to 99% purity, is quoted at Sheffield at 5s. 9d. per lb. Ferro-chrome, 4 to 6% carbon, 60% chrome, is £38, with 12½s. per unit above and below. For 6 to 8% carbon, 60% chrome, the price is £36, and the scale 10s. per unit. Special refined, 2% carbon, 60% chrome, £120, scale 36½s.

SILVER.—The market was steady early in the month rising at the end and has been dependent mainly on coinage orders. American sales were restricted in the first part of the month, but increased as prices rose. Daily quotations will be found on the next page.

PRICES OF CHEMICALS. August 5.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	18	0
,, 60%	,,	4	9	0
,, Glacial	,,	8	15	0
Alum	per ton	14	0	0
Alumina, Sulphate of	,,	18	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	13	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	36	0	0
Barium Chloride	,,	31	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	20	0	0
Borax	,,	34	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	55	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	5	0
Lead, Acetate of, white	,,	96	0	0
,, Chemical Sheet Metal	,,	39	0	0
,, Nitrate of	,,	72	0	0
,, Oxide of, Litharge	,,	43	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	9
Phosphoric Acid	,,			11
Potassium Bichromate	,,		1	10
,, Carbonate	per ton	135	0	0
,, Chlorate	per lb.		2	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb.		9	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	6
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	75	0	0
,, Bicarbonate	,,	6	10	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	17	10	0
,, Hyposulphite	,,	15	0	0
,, Nitrate, 95%	,,	18	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	12	6
,, Sulphide	,,	22	0	0
Sulphur, Roll	,,	13	0	0
,, Flowers	,,	13	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	6
Tin Chloride (Tin Crystals)	,,		1	4
Zinc Chloride, solution 100°T.	per ton	31	0	0
Zinc Sulphate	,,	27	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
July 1915	742,510	27,845	770,355	3,272,258
August	749,572	29,191	778,763	3,307,975
September	749,235	27,515	776,750	3,299,423
October	769,798	27,833	797,631	3,388,122
November	753,605	27,408	781,013	3,317,534
December	755,101	26,010	781,111	3,317,949
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767
July	733,485	27,602	761,487	3,232,891

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
January 31, 1915	172,331	8,675	—	181,006
February 28	180,422	8,494	—	188,916
March 31	185,239	8,216	—	193,455
April 30	186,941	8,418	—	195,359
May 31	183,961	8,857	—	192,818
June 30	184,155	9,019	—	193,174
July 31	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247
May	2,382,298	26 7	18 2	8 2	977,263

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	333,070	135,289	127,107
July	336,565	—	140,290	—
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	1,963,962	1,706,473	825,364

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
Total, 1914	51,454	1,181,520	1,232,974	5,237,308
Total, 1915	17,277	1,192,790	1,210,067	5,140,189
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181
July	555	98,859	99,414	422,271

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	72,200	18,000
July	154,800	—	88,830	—	—
August	80,300	—	93,050	—	—
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	535,500	1,078,560	494,400	206,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	191,404
August	193,998	196,560	197,984	—
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	1,140,170

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard	Silver
July	£ s. d.	£	£ s. d	£	£ s. d.	d.
3	101 15 0	134	28 0 0	51	172 5 0	31
4	98 10 0	133	28 0 0	48	170 5 0	30¾
5	96 10 0	133	28 0 0	46	172 5 0	30¼
6	96 10 0	132	28 0 0	46	173 5 0	30¼
7	90 0 0	130	27 17 6	44	173 5 0	29 15/16
10	84 0 0	130	28 0 0	44	170 0 0	28⅝
11	87 10 0	130	28 0 0	44	168 10 0	29½
12	93 0 0	127	28 0 0	45	169 5 0	29½
13	90 0 0	127	28 5 0	45¼	169 15 0	30
14	90 10 0	126	28 5 0	45½	169 0 0	29⅞
17	88 0 0	125	28 5 0	48	166 10 0	29 15/16
18	88 0 0	124	28 10 0	48	163 10 0	29¾
19	89 0 0	124	28 10 0	50	163 5 0	29⅝
20	90 0 0	123	28 0 0	51	166 10 0	29¾
21	90 0 0	124	28 12 6	54	168 5 0	30 3/16
24	93 0 0	124	27 15 0	56	166 0 0	30⅛
25	97 0 0	124	27 17 6	59	165 15 0	29 15/16
26	100 0 0	125	27 17 6	59	165 15 0	30⅛
27	105 10 0	125	28 0 0	59	165 15 0	30⅜
28	111 5 0	126	28 0 0	60	168 5 0	30 5/16
29	111 0 0	126	28 0 0	66	168 0 0	30¼
31	111 5 0	127	28 5 0	60	168 10 0	30 9/16
Aug.						
1	108 10 0	127	28 7 6	55	167 5 0	30½
2	106 10 0	127	28 10 0	50	167 10 0	30½
3	106 10 0	127	28 10 0	47	168 0 0	30⅞
4	106 0 0	127	28 10 0	47	167 10 0	30 13/16
5	107 0 0	127	28 10 0	47	168 10 0	31½
7	106 10 0	126	28 15 0	44	167 10 0	31 7/16
8	107 0 0	126	28 15 0	44	167 10 0	31⅝
9	109 0 0	126	29 2 6	47	168 0 0	31 5/16
10	110 10 0	126	29 2 6	47	169 10 0	31⅝

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	June 1916	July 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	1,474	2,962	20,348
,, Matte and Precipitate	38,372	4,787	2,208	24,722
,, Metal (unwrought and part wrought)	180,368	11,551	9,252	69,053
Copper and Iron Pyrite	903,401	60,388	95,302	609,427
Tin Concentrate	44,748	2,225	2,279	18,181
,, Metal	38,896	2,590	3,306	21,068
Manganese Ore	377,324	50,826	33,817	259,309
Lead, Pig and Sheet	256,476	11,550	5,916	93,844
Zinc (spelter)	74,520	4,561	4,884	24,681
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	—	270,249	2,379,539

Stocks of Copper.
Reported by Henry R Merton & Co. Ld. Long tons

	May 31, 1916	June 30, 1916	July 31, 1916
	Tons	Tons	Tons
Standard Copper in England	1,957	2,148	1,382
Fine Copper in England	935	2,070	2,058
,, ,, Havre	3,770	3,385	2,525
,, ,, Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*
,, ,, Afloat from Chile	3,000	2,225	2,175
,, ,, ,, from Australia	4,100	4,000	3,500
Total Visible Supply	18,785	18,951	16,763
In other European Ports Estimated	—	—	—

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1916	Long tons	1916	Long tons
July	16,812	January	21,863	July	—
August	16,289	February	20,548	August	—
September	14,327	March	24,006	September	—
October	26,153	April	19,980	October	—
November	19,396	May	14,700	November	—
December	32,936	June	38,277	December	—
Total 1915	257,915	Total 1916	139,374	Total 1916	—

Stocks of Tin.
Reported by A. Strauss & Co Long tons.

	May 31, 1916	June 30, 1916	July 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,862	1,537	1,074
Ditto, Landing and in Transit	650	225	1,190
Other Standard, Spot and Landing	1,862	1,399	1,595
Straits, Afloat	2,960	5,125	3,640
Australian, Afloat	500	500	500
Banca, on Warrants	—	—	—
Ditto, Afloat	4,375	3,640	1,067
Billiton, Spot	—	—	—
Ditto, Afloat	123	400	393
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,010*	1,450*	1,825
Afloat for United States	5,190	3,325	4,667
Stock in America	2,468	3,963	5,028
Total Stock	21,000	21,564	20,976

* Including 705 tons on board enemy's ships either captured or lying in neutral ports

Shipments and Imports of Tin
Reported by A. Strauss & Co. Long tons.

	Year 1915	June 1916	July 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	3,665	1,860	16,145
Straits to America	31,565	1,700	2,530	16,430
Straits to Continent	11,024	845	1,020	5,210
Australia to U.K.	2,481	228	119	1,789
U.K., Holland, and Continent to America	14,967	1,515	2,137	8,808
Imports of China Tin into U.K. and America	3,012	240	—	1,190
Imports of Bolivian Tin into Europe	22,591	770	1706	7,277

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	510
July	140	357	432	455	—
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	3,138

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	3,499
August	4,454	4,620	3,591	4,046	—
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	25,224

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
September 27	171½	£14,459	£84 6 3
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10
July 17	186⅓	£17,114	£91 15 4
July 31	172¼	£16,172	£93 17 8

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	Aug. 3 1915	July 5 1916	Aug. 4 1916
RAND:			
Bantjes	9	14	14
Brakpan	60	85	90
Central Mining (£12)	125	129	127
Cinderella	3	6	6
City & Suburban (£4)	42	39	39
City Deep	62	80	80
Consolidated Gold Fields	25	32	31
Consolidated Langlaagte	37	35	32
Consolidated Main Reef	19	20	19
Consolidated Mines Selection (10s).	9	16	18
Crown Mines (10s.)	85	61	60
Daggafontein	8	15	15
D. Roodepoort Deep	16	15	14
East Rand Proprietary	26	15	14
Ferreira Deep	41	27	27
Geduld	29	45	44
Geldenhuis Deep	21	26	26
Gov't Gold Mining Areas	[illegible]	37	40
Heriot	56	50	47
Jupiter	6	8	8
Kleinfontein	23	29	28
Knight Central	7	12	14
Knight's Deep	27	29	25
Langlaagte Estate	19	19	19
Luipaard's Vlei	7	9	8
Main Reef West	6	7	7
Meyer & Charlton	110	111	106
Modderfontein B	105	136	136
Modder Deep	84	134	136
Modderfontein, New (£4)	294	341	349
Nourse	23	14	15
Rand Mines (5s.)	89	73	72
Randfontein Central	11	11	10
Robinson (£5)	35	20	24
Robinson Deep	22	19	25
Rose Deep	35	25	26
Simmer & Jack	10	7	7
Simmer Deep	1	2	2
Springs	22	55	58
Van Ryn	55	44	40
Van Ryn Deep	51	70	75
Village Deep	37	31	31
Village Main Reef	29	17	15
Witwatersrand (Knight's)	61	59	60
Witwatersrand Deep	32	25	27
Wolhuter	11	10	10
OTHER TRANSVAAL GOLD MINES:			
Glynn's Lydenburg	10	230	15
Sheba (5s.)	3	15	2
Transvaal Gold Mining Estates	33	67	25
DIAMONDS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	197	105	222
Jagersfontein	52	2	66
Premier Diamond Defer'd (2s. 6d.)	85	26	102
RHODESIA:			
Cam & Motor	11	14	13
Chartered	10	14	13
Eileen Alannah	6	9	9
Eldorado	10	11	10
Enterprise	5	6	5
Falcon	7	16	14
Giant	5	7	6
Globe & Phœnix (5s.)	26	26	25
Lonely Reef	21	24	24
Shamva	34	36	30
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	5	5	5
WEST AFRICA:			
Abbontiakoon (10s.)	8	8	7
Abosso	7	10	9
Ashanti (4s.)	16	18	19
Broomassie (10s.)	½	½	½
Prestea Block A	10	10	9
Taquah	14	19	19
WEST AUSTRALIA:			
Associated Gold Mines	4	4	4
Associated Northern Blocks	4	4	3
Bullfinch	6	5	4
Golden Horse-Shoe (£5)	45	35	37
Great Boulder Proprietary (2s.)	14	13	13
Great Boulder Perseverance	1	1	1
Great Fingall	3	2	2
Ivanhoe (£5)	44	44	44
Kalgurli	31	12	12
Sons of Gwalia	16	16	15
Yuanmi	2	3	2¾

GOLD, SILVER, *cont.*	Aug. 3 1915	July 5 1916	Aug. 4 1916
OTHERS IN AUSTRALASIA:			
Blackwater	15	15	15
Consolidated Gold Fields of N.Z.	11	6	6
Mount Boppy	10	10	14
Mount Morgan	44	40	37
Progress	5	4	4
Talisman	21	12	12
Waihi	37	37	42
Waihi Grand Junction	21	19	19
AMERICA:			
Alaska Treadwell (£5)	140	117	115
Buena Tierra	8	12	13½
Camp Bird	4	9	8
Canadian Mining	8	12	12
Casey Cobalt	6	7	6
El Oro	7	9	9
Esperanza	8	11	11
Frontino & Bolivia	9	11	11
Le Roi No. 2 (£5)	10	10	10
Mexico Mines of El Oro	67	80	72
Oroville Dredging	15	17	16
Plymouth Consolidated	18	27	23
St. John del Rey	14	16	16
Santa Gertrudis	7	14	12
Tomboy	20	22	22
RUSSIA:			
Lena Goldfields	32	32	36
Orsk Priority	9	21	22
INDIA:			
Champion Reef (2s. 6d.)	10	7	6
Mysore (10s.)	76	80	77
Nundydroog (10s.)	25	29	26
Ooregum (10s.)	25	22	21

COPPER:

	Aug. 3 1915	July 5 1916	Aug. 4 1916
Anaconda (£10)	149	347*	330*
Arizona Copper (5s.)	—	40	40
Cape Copper (£2)	50	77	80
Chillagoe (10s.)	½	½	½
Cordoba (5s.)	3	4	3
Great Cobar (£5)	1	3	3
Hampden Cloncurry	30	39	36
Kyshtim	35	49	51
Messina (5s.)	14	11	11
Mount Elliott (£5)	60	77	77
Mount Lyell	23	26	26
Rio Tinto (£5)	1100	1235	1225
Sissert	19	19	26
South American Copper (2s.)	11	15	15
Spassky	40	42	43
Tanalyk	35	45	52
Tanganyika	24	53	50

LEAD-ZINC:

	Aug. 3 1915	July 5 1916	Aug. 4 1916
BROKEN HILL:			
Amalgamated Zinc	24	35	33
British Broken Hill	22	25	24
Broken Hill Proprietary (8s.)	44	60	61
Broken Hill Block 10 (£10)	21	23	23
Broken Hill North	39	47	46
Broken Hill South	137	167	170
Sulphide Corporation (15s.)	17	27	26
Zinc Corporation (10s.)	12	15	15
ASIA:			
Burma Corporation	34	61	66
Irtysh Corporation	30	44	50
Russian Mining	14	17	24
Russo-Asiatic	75	110	124

TIN:

	Aug. 3 1915	July 5 1916	Aug. 4 1916
NIGERIA:			
Bisichi	5	9	8
Ex-Lands Nigeria (2s.)	1	1½	1¼
Mongu	9	8	8
Naraguta	12	14	14
N. Nigeria Bauchi (10s.)	2	2	2
Rayfield	3	6	5
Ropp (4s.)	12	17	16
OTHER COUNTRIES:			
Aramayo Francke	27	27	27
Briseis	4	5	5
Cornwall Tailings	15	4	4
Dolcoath	6	12	11
East Pool	8	35	36
Gopeng	26	32	30
Pahang Consolidated (5s.)	6	11	11
Renong Dredging	20	30	30
Siamese Tin	50	55	51
South Crofty (5s.)	5	17	16
Tekka	60	62	62
Tronoh	27	30	30

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[*In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

ISHERWOOD'S ZINC PROCESS.

The Venture Trust announces the formation of the British Electrolytic Zinc Company, with the object of working Dr. P. C. C. Isherwood's process for producing a pure electrolytic zinc from complex sulphide ores. The plant is in course of erection at Widnes, Lancashire. The promoters state that an experimental unit was in operation for nine months at the Raritan works of the Anaconda company, but as far as we are aware the process was not adopted for treating the Anaconda zinc ores. Pending the publication of an official description of the process, we may profitably examine Dr. Isherwood's patent specifications. His British patents are 16,364 of 1906, 4358 of 1909, 21,584 of 1909, 22,855 of 1912, and 6413 of 1913. The first patent describes the use of a solution of an ammonium salt such as the chloride or sulphate for leaching roasted zinc-lead sulphide, but we may leave this process out of consideration. Patents 21,584 of 1909 and 22,855 of 1912 describe a method of dissolving the zinc by sulphuric acid under conditions of high temperature and pressure. Patents 4358 of 1909 and 6413 of 1913 relate to filtering apparatus suitable for this class of process. Patent 21,584 of 1909 contains the essence of the process. The idea of leaching zinc ore under high pressure and temperature is of course not new. His claim relates to the use of a less amount of sulphuric acid than is required for dissolving the zinc oxide at ordinary pressure and temperature, with the object of preventing the acid dissolving the iron content as well. The following is extracted from the specification :

"The ore after being ground is roasted advantageously under conditions in which the oxidizable sulphides in the ore are converted partly into sulphate and partly into oxide and under conditions which give a maximum yield of sulphate and until no free sulphide remains; and is then leached with a solution of sulphuric acid at high temperature and pressure.

"Hitherto the use of sulphuric acid for the extraction of zinc from ores containing iron has been open to the objection that a portion of the iron is dissolved with the zinc when sufficient acid has been used for the complete solution of the latter. When less than the theoretical quantity of acid necessary for solution of the zinc oxide is used, much less iron is dissolved, but in this case under ordinary conditions a considerable amount of zinc is left in the residue.

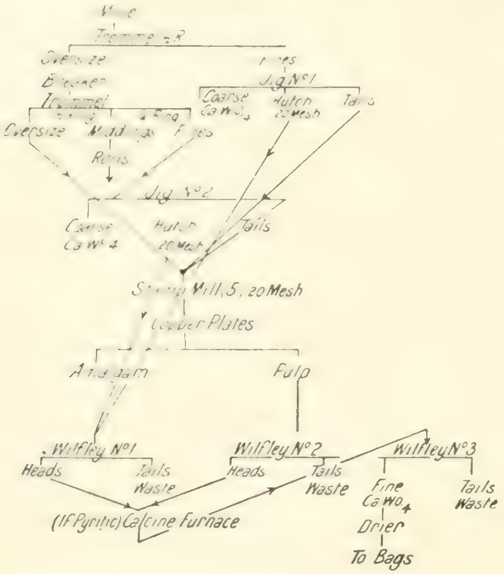
"The solubility of zinc oxide in solutions of zinc sulphate is increased at temperatures above the boiling point under atmospheric pressure, such as correspond to pressures of say from 50 to 200 lb. per square inch. As a result of this fact a practically complete removal of zinc can be made free from contamination with iron with less than the theoretical quantity of sulphuric acid necessary to convert the whole of the zinc oxide into zinc sulphate; and conversely should excess of sulphuric acid have been used and iron be found in the zinc sulphate solution it can readily be removed by a subsequent treatment with more ore under these leaching conditions."

Dr. Isherwood's patents say nothing of the electrolysis of the zinc solution, but it is clear that, with the iron and other impurities eliminated, no modification of ordinary electrolytic practice would be required.

SCHEELITE MINING IN NEW ZEALAND.

In the *Proceedings*, No. 21, 1916, of the Australasian Institute of Mining Engineers, C. W. Gudgeon describes the deposits of scheelite (tungstate of lime) in Otago Province, New Zealand. The mineral has been found in many parts of the province, but only in two districts have the operations been on a commercially productive scale. One of the centres is at Glenorchy, which is on the northern side of Wakatipu lake, and about 240 miles northwest of Dunedin, and the other is at Macrae's Flat, 50 miles due north of Dunedin. In the first-named district the Glenorchy mine, and in the latter district the Golden Point mine, are regular producers. The Highlay Mine at Macrae's Flat was also worked regularly for a number of years, but operations were suspended in 1913. Many other properties have at one time or another shown promise, but owing to the patchiness of the scheelite they were not worked at a profit and the owners were compelled to close down. Most of the scheelite deposits contain gold. Sometimes the gold is the more important constituent of the ore, with scheelite as a by-product, and in other parts of the district scheelite has been the chief source of revenue. At the Glenorchy the scheelite is more important than the gold, and at Macrae's Flat the extraction of the gold was the chief object. The first attempt to establish a scheelite industry was made during the years following 1875, when work was done under the direction of Professor Ulrich, of the Otago School of Mines, on the property now owned by the Glenorchy company. The low price of scheelite caused the venture to be abandoned, and the mine was idle until 1905, when the present company took it in hand and made it a success. The Golden Point mine was started as a gold producer in 1891 by Donaldson Brothers. Some years later the value of the scheelite was recognized, and a concentrate was made that was readily saleable in Germany.

The scheelite is found in quartz veins traversing mica schists of probably Devonian age. We may here interpolate the information that an elaborate description of the geology of the deposits was given by A. M. Finlayson in the *Transactions* of the New Zealand Institute, Vol. 40. At Macrae's Flat the



Flow-Sheet at the Glenorchy Scheelite Mine.

veins are of the bedded type, and at Glenorchy of the fissure type. Below the zone of oxidation the scheelite is associated with pyrite and arsenopyrite. It occurs irregularly in pockets and lenticles in the quartz. At the Golden Point mine, the best parts are picked and sent to the surface separately, where they are cobbed to produce a shipping concentrate averaging 60 to 65% WO_3. The reject goes with the rest of the ore to the mill. In our issue of January 1914 we gave an outline of the mill practice, extracted from a paper by Mr. Gudgeon appearing in the *Australian Mining Standard*, so we need not give full details on this occasion. Briefly, the oxidized ore is crushed to 30 mesh, passed over amalgamating tables, then over concentrating tables to remove the scheelite, the sand tailing treated with cyanide, and the slime tailing stored. When pyritic ore is treated, the pyrite is removed with the scheelite, and the concentrate averages 30–40% scheelite, 50–55% pyrite, and 10% silica, together with 2½ oz. gold per ton. To separate the pyrite, the concentrate is sent to a roasting furnace where the pyrite is given a magnetic roast, so that it can be removed in a Wetherill concentrator. In the first stage a substantial proportion (say 15%) of the scheelite goes over with the pyrite, so the iron product is given another roast and passed again through the magnetic machine. A good deal of the gold is recovered with the pyrite.

At the Glenorchy mine the scheelite is more important than the gold. As the mineral is friable, a system of treatment was adopted in order to reduce the sliming to a minimum. The ore as it comes from the mine is passed through a trommel having ½ in. apertures. The fine is sent to a jig (No. 1), producing a concentrate, a hutch product (20 mesh), and tailing. The oversize is broken and passed through a trommel having ½ in. and ¼ in. apertures. The fine is sent to No. 2 jig where similar products are made as in No. 1 jig. The middling is passed through rolls and sent to No. 2 jig. The oversize is sent to a stamp-mill with 20 mesh screen, together with the tailing from Nos. 1 and 2 jigs. The hutch product of Nos. 1 and 2 jigs is sent to a Wilfley table, and the battery pulp, after going over amalgamating plates, is sent to another Wilfley. The concentrate from these two tables, if pyritic, is roasted, and treated on a third Wilfley.

ZINC AND LEAD IN RHODESIA.

In a report made to the Rhodesian Broken Hill Development Co., Ltd., S. J. Speak gives interesting details regarding the Broken Hill deposits. These are important as being, as yet, the only large deposits of zinc and lead known in South Africa. They are carbonates and owing to the intimate mixture of the lead and zinc, coupled with the long distance from market, have so far proved unprofitable. A variety of processes have been tried without any considerable success. Mr. Speak finds it possible to mine an ore relatively high in lead and to smelt in the usual fashion, throwing the zinc into a slag which is of possible value later. This is now being done and additional furnaces are being built. The zinc problem remains to be solved, though it is considered to be far from unsolvable. Mr. Speak's description of the deposits and works, in part, follows :

The country is flat, and so much covered with soil and clay that almost the only rocks naturally exposed are the outcrops of orebodies. No. 1 kopje is a rugged rock about 250 ft. in diameter rising above the surrounding flat country to a height of 65 ft. ; the whole of the kopje is highly mineralized and may be regarded as roughly indicating the present known limits of this particular orebody. There are seven other kopjes within a radius of one mile of No. 1, and somewhat similarly mineralized. Little is known about the geological structure of the country. No. 1 kopje is surrounded by massive magnesian limestone ; No. 2 by massive and schistose limestone ; indeed, limestone appears to be the prevailing country rock. No local data are available upon which to build any hypothesis as to the probable extent or nature of the ores in depth, though a bore-hole was sunk some years ago at No. 1 kopje to a depth of 90 ft. below water level, and was in ore all the way. There is no ground for fearing limited extension in depth, though being limestone deposits, great irregularity in their size may be expected. Theory is, however, useful in another direction. It is well known that the action of surface waters on the sulphides of zinc and lead is greatest upon the zinc mineral. A close examination of No. 1 kopje discloses the oxidized remains of the original orebody running through the centre of the kopje surrounded by a material that was originally limestone, but which has since been partly replaced by zinc minerals. Such replaced limestone appears to withstand the corrosive action of the elements better than the original limestone, and probably for that reason it forms kopjes. There may exist in the neighbourhood still undiscovered orebodies of lead containing little zinc. At the surface the zinc has often migrated as much as 100 ft., therefore in this district the original orebody is not necessarily immediately beneath an outcrop. Mr.

Speak did not consider it necessary to re-sample any of the mines, because recent mining has fairly well confirmed the assay values on which the official estimate in use for some years past was based. None of the deposits have been so completely developed as professional custom requires for an estimate of 'Ore blocked out,' but even if they had been possible vughs and cavities in the deposits would cause a possible error of about 10%. He estimated that there is now available above water level in No. 1 kopje approximately 55,000 tons of ore averaging 38% lead and 18% zinc. For many years it has been known that some portions of No. 1 kopje were richer than others, but it was supposed that there was no regularity of distribution and that the ore of the kopje must be regarded as a whole averaging 26% Pb and 22% Zn. Careful examination shows that instead of mining 140,000 tons of ore of the above average it would be quite feasible to mine separately 55,000 tons averaging about 38% Pb and 18% Zn; this would leave a remainder of 85,000 tons averaging about 18% Pb and 25% Zn, which, if necessary, could be further classified during mining. This changes the metallurgical problem. The proper way of dealing with this 55,000 tons of higher grade lead ore is to smelt it direct; this is being done today successfully in a mere toy of a furnace; the problem of treating the poorer qualities is not quite solved. The old estimate of the ore in No. 2 kopje above water level is 300,000 to 320,000 tons averaging 32% zinc; this needs qualifying by the addition of the words 'probable and possible' ore. Although the full amount may exist, there is an element of chance about it.

The experimental plant consists of: (1) A Murex unit capable of treating about 24 tons of ore per day. (2) Three Wilfley tables with classifiers. (3) Sintering hearths for fine ore and concentrates. (4) A blast-furnace 4 ft. in diameter. (5) A reverberatory furnace with bag house for the collection of zinc fume. (6) Power plant, crushers, elevators, fans, blowers and other adjuncts. The original object of the plant was to ascertain the relative merits of the Murex process of concentration and the ordinary water concentration in the separation of the lead and zinc minerals contained in the ore. The small blast-furnace was erected to treat the lead concentrates thus produced. The blast-furnace was blown in about the middle of June last, and has since run with frequent stoppages. The process of smelting adopted differs from ordinary lead smelting in that an iron slag containing up to 20% ZnO is aimed at instead of the usual lime-iron slag which will not carry that amount of ZnO. Many difficulties were encountered, and some have not yet been completely overcome, but they are not serious. The original intention was that the furnace should operate only on sintered concentrate, but when it was found that the presence of zinc was not so troublesome as anticipated, some selected ore from the mine was smelted direct. During the months of November and December 1915 the blast-furnace was operating almost entirely on raw ore from the mine, and the results were satisfactory, with the exception that the quantity of lead produced was not so great as it would have been had it worked entirely on rich concentrate. The zincy slag from the blast-furnace is heated together with fine coal in a reverberatory furnace, when the greater part of the zinc in the slag is volatilized away. The de-zinced slag can then be used again in the blast-furnace to absorb more zinc. In a larger installation the hot slags from the blast-furnace would be transferred direct to the de-zincing furnace, and the hot gases from this furnace would be used under steam boilers, so that the cost of driving off the zinc would not be very great, and further, the de-zinced slag would be valuable as a flux. The present furnace being so small cannot be operated on proper economical lines, and so long as there is no local market for the zinc fume produced it cannot be operated profitably and is therefore only of value as a demonstration plant.

The general conclusions based on the working of the experimental plant are: (*a*) With ore assaying about 25% Pb and 25% Zn the Murex plant will extract 70 to 75% of the Pb as a concentrate assaying 50 to 60% Pb and 10 to 15% Zn. (*b*) Water concentration on similar ore will give about 60% extraction and probably more with a complete plant. (*c*) Neither method of concentration gives as good extraction on ores containing less lead than above. (*d*) Neither method will produce a high-grade zinc concentrate. (*e*) The coke consumption of the blast-furnace is about the same as in ordinary lead smelting. (*f*) Iron-stone flux being cheaply obtained, it is not very costly to produce extra slag purposely to absorb any excessive amounts of zinc in the ore charged into the furnace. (*g*) There is every probability that when working on a large scale zinc oxide can be recovered from the slags quite cheaply.

As to zinc production Mr. Speak states that in No. 2 kopje there is believed to be already partly developed about 300,000 tons of ore containing about 32% Zn and a small percentage of lead. The low-grade ores already developed in No. 1 kopje, together with the tailings present and future from the operation of the oil and water concentration plants, will provide fully 50,000 tons of material containing 30 to 35% Zn. and 10 to 15% lead. Ores containing zinc have also been disclosed in other outcrops and kopjes. None of these surface ores can be properly beneficiated by either water or oil concentration, and some other process of turning them to profitable account must be found, as they are of too low a grade for profitable shipment.

SELLING ZINC CONCENTRATE.

In the treatment of complex zinc-lead sulphides the production of lead and zinc concentrates that yield the highest profit presents a problem of some intricacy. The highest percentage of recovery in concentration plant does not necessarily mean the highest profit, for some part of the metallic content may not be eventually extracted or paid for by the buyers. For instance the zinc contained in lead concentrate is entirely lost. Wilton Shellshear makes some useful comments on this subject in an article published in the *Mining and Engineering Review* of Melbourne for May. He points out that the flotation process of concentration has one great advantage as, by its means, the final products of concentration may be varied over wide limits in order to gain the greatest advantages from the selling contracts.

Zinc metallurgy has changed greatly during recent years. Not so long ago lead and silver were not desirable contents of zinc concentrate, but nowadays these are recovered from retort residue, and their absence involves a penalty. On the other hand lead under 8% and silver under 5 oz. is not paid for.

Under pre-war conditions, the Germans usually bought zinc concentrate under a formula similar to the following :

Value of concentrate in shillings $= \frac{0\ 85\ S.G - [illegible]}{100} - R$

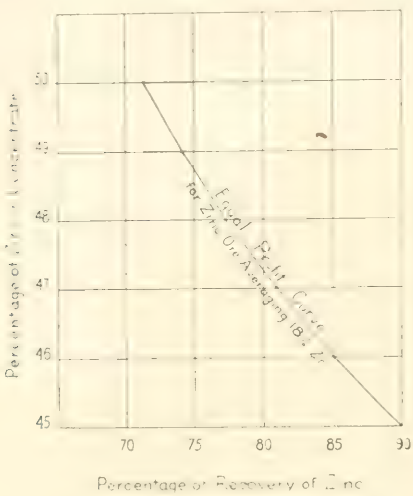
Where G = percentage grade of concentrate.

S = London price of spelter in shillings.

R = returning charge, varying from 100s. to 120s. per ton, according to the price of spelter.

For the lead in the concentrate eight units were deducted, and for the silver five units, and the remainder paid for at half the market rates. By working out this formula, it will be found that a rise of 1% in the grade of zinc in the concentrate means an extra 4s. to 5s. per ton of concentrate.

The effect of grade is now, however, far more important than represented by this formula, and different conditions are imposed for each class of material sold. Since the war zinc concentrate has been sold under flat rates, with a rise in value per unit similar to pre-war contracts. But the price of the concentrate varies with the minimum basis under which it is sold. For instance, zinc concentrate sold under the basis of 42% minimum will bring far less than if sold under a 45% minimum, the difference in price being much more than is represented by the difference of 4s. per unit between the 42% and 45% grades. In valuing an ore of this class the composition of the blende itself must be considered. The fact that the Broken Hill type is the iron blende known as marmatite, averaging approximately 56% zinc, as compared with pure rosin blende containing over 60%, has made a difference of thousands of pounds to the Broken Hill companies.



CURVE OF EQUAL PROFITS.

Any process for removing more lead and silver from a lead-zinc ore as a lead concentrate increases the profits in two ways. More lead and silver are paid for, and a more valuable zinc concentrate is produced. Thus it will be seen that preferential flotation on the Broken Hill ores means considerably more profit to the companies than the extra amount of lead saved as a lead concentrate, and the greatly improved recovery of silver. Broken Hill may be said to have started on a new profit-making era after preferential flotation was introduced, because the extra recoveries of lead and silver caused a rise of grade in the zinc concentrate produced. In choosing a preferential process for the treatment of a lead-zinc ore, it is wise to investigate carefully whether the silver follows the lead concentrate or the zinc concentrate. It is needless to say that this is a most influential factor in future profits.

In the valuation of zinc ores it is necessary to consider the effect of pyrite and other diluting sulphides, and also of fluorspar and calcite. Even 5% of sulphides will reduce the value of a zinc concentrate over £1 per ton. Zinc smelters do not like fluorspar owing to the serious effects of the silicon tetrafluoride produced, and concentrate containing an appreciable quantity of this mineral is practically unsaleable. Calcite, if in sufficient quantity, may make some types of ore not amenable to economical flotation, owing to high acid consumption, but this difficulty is gradually being overcome by the rapid advance of new processes without the use of acid.

Mr. Shellshear gives two specific examples of the problems which confront the engineer. In the first case, zinc ore assays 18% zinc. The question arises: What recovery with a grade of 50% will be necessary to obtain the same profit as a 90% recovery with a grade of 45%. As a basis for calculation it is assumed that a flat rate of 50s. per ton is paid on a minimum basis of 45%, with a rise of 4s per ton for every unit of zinc above this standard. The accompanying curve fully illustrates the solution to this problem.

The second problem relates to an ore containing 15% lead, 10 oz. silver, and 15% zinc. This ore is treated by two different methods. The first method makes a recovery of 80% of the lead and 60% of the silver in a concentrate assaying 60% lead, 30 oz. silver, and 6% zinc; and a further recovery of 73.6% of the zinc in a concentrate assaying 7% lead, 8 oz. silver, and 47% zinc. The second method makes a recovery of 70% of the lead and 52% of the silver in a lead concentrate of the same assay as obtained by the first method; and a further recovery of 87% of the zinc as a concentrate assaying 12% lead, 13 oz. silver, and 40.8% zinc. The question is which method, assuming working costs the same in each case, makes the greatest profit.

FIRST METHOD.

	Assay.			Tons.	Recoveries.			Value.
	Lead. %	Silver.	Zinc. %		Lead.	Silver.	Zinc.	£
Crude ore ...	15	10	15	100				
Lead concentrate	60	30	6	20	80.0	60.0	8.0	£200
Zinc concentrate	7	8	47	23.5	11.0	18.8	73.6	£70.5
Totals					91.0	78.8	81.6	£270.5

Lead concentrate estimated value £10 per ton.
Zinc concentrate estimated value 60s. per ton.

SECOND METHOD.

	Assay.			Tons.	Recoveries.			Value.
	Lead.	Silver.	Zinc. %		Lead.	Silver.	Zinc. %	£
Crude ore ...	15	10	15	100				
Lead concentrate	60	30	6	17.5	70.5	52.5	7.0	£175
Zinc concentrate ...	12	13	40.8	32	25.6	41.6	87.0	£64
Totals .					95.6	94.1	94.0	£239

Under the same basis as the first method, lead concentrate is worth £10 per ton and zinc concentrate under £2 per ton, but a value of £2 is taken here.

The results show at least 6s. per ton in favour of the first method. It is interesting to note the differences in the total recoveries of metals obtained in both cases.

MOLYBDENITE IN NORWAY.

In the *Bulletin* of the Canadian Mining Institute for July, H. H. Claudet gives some first-hand information relating to the chief molybdenite deposits in Norway. As he remarks, little information has been published in the English language in connection with these deposits, and such as has appeared has often been incorrect. As Norway is one of the chief producers of molybdenite, and as the prospects for an increased output are excellent, Mr. Claudet's contribution is timely. We may here remark that Mr. Claudet has for some years been engaged on work connected with the Elmore vacuum flotation process, and that he erected plant at the two mines he describes in his article.

The two chief producers belong to the Knaben and Kvinas companies. They are situated at Knabeheien, near the Kvinas valley, north of Flekkefjord. Their combined output of concentrate averaging 75% MoS_2 was 72 tons in 1914, and 87 tons in 1915. The mineral is found in narrow quartz veins traversing granite. Other gangue minerals are felspar, mica, and hornblende, and pyrite, chalcopyrite, and pyrrhotite occur in varying quantities. Otto Falkenberg, the manager of the Kvinas mines, describes the geology thus: "The deposits are associated with granite and partly granite-gneiss. They appear to some extent in intimate association with massive pegmatite, especially at the boundary of the pegmatite with the surrounding granite. In other places one can best speak of molybdenite-bearing quartz-rock, and there are also occurrences of the mineral direct in the granite without any accompanying kind of vein matter. This last is, however, usually of little extent, and seems to be confined to small veins which intersect the granite. Owing to its intimate association with the pegmatite, the want of a distinct boundary between the vein and the surrounding granite, together with the appearance of flourspar, the author considers these occurrences to be formed at any rate partly by pneumatolytic action in connection with the ascending ore-bearing solutions. Their formation is to be considered as the last after-effect of the granite eruptions. The ore-bearing zones are intersected by several diabase dikes running approximately E-W, having a width up to five metres. They do not appear to have any special influence on the ore occurrence. The diabase dikes can be followed for several kilometres. The ore-bearing zone is about one kilometre broad and has a longitudinal extent from north to south of about twenty kilometres. A further continuation is not out of the question, as the same granite continues also beyond the present known ore-bearing zone, but is little explored. A red granite variety, whose red colour is due to large orthoclase crystals, must be considered as quite unmetallic."

As will be gathered from the foregoing, this molybdenite ore-zone is extensive, but so far there is nothing to prove that the ore will be found at any depth, as all the workings are quite shallow. Probably the deepest point does not exceed thirty metres vertical depth (about 65 metres on the dip). While there does not seem to be any decided opinion formed yet, it can at any rate be stated that in many places where underground work has been pursued the ore has been found to disappear at varying shallow depths, the vein sometimes pinching out and sometimes becoming barren. The molybdenite usually is finely disseminated throughout the gangue, but at the Knaben mines where most underground work has been done, considerable enrichment is to be noted in places, where rich pockets of large size have been found, sometimes producing massive pieces of molybdenite. In parts of this mine some of the stopes will measure about 10 metres across the lode.

There is no timber supply close to the mines but fortunately practically no timbering is required underground, but in the case of the large stopes at the Knaben mines the manager has put in reinforced concrete pillars with satisfactory results. All the mining is done by hand work. No regular sampling of the mine ore is customary in this district, the miners, under careful supervision, trusting to their eyes. The success of these original companies and the present demand for molybdenum has resulted in great activity in these parts, several new companies having been formed to exploit and develop the surrounding claims.

With regard to ore treatment, both companies are using the Elmore vacuum process. The ore is crushed to about 1 m.m. (sometimes coarser) and separated in one operation, no roasting or preliminary sizing or concentrating being required. A very small quantity of oil is used and no acid. The plant is simple and cheaply operated. As it is possible to float comparatively large particles of molybdenite, a coarse mesh can be used, thereby minimizing the percentage of slime and simplifying the crushing arrangements. Originally, at one of the mines primitive methods were used, a crude separation being effected by boys picking the molybdenite out of the high-grade ore with penknives. In 1906 operations were begun on a more elaborate scale, and a wet concentrator, consisting of jigs and tables, was completed in 1907. This did not work for long, and was idle from 1909 to 1913. In 1914 an Elmore plant was erected, after comparative trial runs had demonstrated that a considerable improvement was thereby effected. At times some very low-grade ores have been treated, particularly at the Kvina mines, at which Elmore plant was installed toward the end of 1913, where the presence of other sulphides and mica presented rather a difficult problem. Commercial results have been obtained from ore as low as 0·4% to 0·5% MoS_2, which is concentrated up to 70%–75% MoS_2 in one operation. On the whole the extraction has been satisfactory, varying according to the grade and nature of the mill-feed. With an ore containing 0·8% to 1·0% MoS_2 over 80% recovery, and a concentrate varying from 75% to 85% MoS_2 is obtained in practice, but when the mill feed is very low the results will correspondingly suffer. The Kvina company has recently added a second Elmore unit to meet the conditions of its mine, and the Knaben company has just decided to make a similar addition.

Reference has been made in various articles to the difficulties of treating molybdenite ores containing mixed sulphides and mica. These mixed sulphide-molybdenite ores have been successfully treated for the last couple of years by molybdenite producers in Norway. The reason molybdenite can be separated from the other sulphides in this manner is attributed to the preference the oil shows for different sulphides, the affinity toward molybdenite being strong. Analyses of these ores are not available, but the mill-feed frequently contains considerable quantities of pyrite, chalcopyrite, and mica, the bulk of which passes into the tailing. It might be assumed in this connection that an ore might conceivably contain so little MoS_2 and so large an amount of other sulphides and mica that the separation would present a difficult problem, but this is a matter which can easily be ascertained beforehand by conducting tests on representative samples from the mine.

METAL LOSSES IN COPPER REFINING.

In *Metallurgical and Chemical Engineering* for July 1, Lawrence Addicks writes of the sources of metal losses and errors in accounting in copper refining, during the production of fine copper, gold, and silver from blister copper. There are errors in weighing, sampling and assaying; there are mechanical losses in weighing, sampling, and handling; and metallurgical losses in the slag, stack, and elsewhere in the course of the processes. We extract information from the article relating to mechanical errors and losses, and in connection with the processes, but we have not space on this occasion for the author's hints on sampling and assaying.

It is not possible to weigh copper in larger lots than 5 tons if accuracy to the nearest pound is required. In practice two platform scales are placed in tandem, separate weighers taking readings and comparing figures before passing a lot. The scales are either of the overhung type where the knife edges are overhead and always in sight, or they are baby railroad scales. The latter are to be preferred as they are free from the obstructions above the floor line, and it is possible to arrange the live platform so that an oncoming car divides the shock between two pairs of knife edges, greatly saving wear. The standard of weight is provided by a certified 50 lb. brass weight. Against this are checked a sufficient number of 50 lb. cast iron weights, adjustable by lead shot, to make up a full-scale load. These weights are not suitable for every-day use, as they afford a great surface for the condensation of moisture, collection of dirt, etc., so a test car loaded with very heavy cast iron weights is checked against them every two or three weeks and this test car is used for daily checks on the merchant scales. As identical methods are used for weighing incoming blister and outgoing wirebars there is only a small chance of tracing any copper losses to scales in a modern plant. One of the most fruitful sources of error in weighing lies in the inaccurate taring of cars. Slight differences are bound to occur daily as the oil works out of the bearings, but this is not serious. Wear and tear gradually lowers the weight of a car, and it should be tared at least every ten days, the weight and date being painted on each side of the car.

In discussing sampling, Mr. Addicks reminds us that it is generally assumed that copper carries no moisture. This question was first raised a good many years ago when some blister copper from Australia that had been immersed in bilge-water in transit was found to carry about 0·5% of moisture. Pig copper is porous and a quart of water poured on the face of a pig will vanish as if absorbed by blotting paper. Some of the Western American smelters are quenching their converter bars in boshes, a practice that raises this question again. All that can be done in such cases is to make careful tests in a drying oven on certain pigs, and to apply the correction found to the lots represented. It is evident that a very serious source of loss may pass unsuspected if this is not watched, as the refinery will be accounting for water as copper, silver, and gold. The weighing of material that has been exposed to inclement weather should never be done, but sometimes it is necessary in order to save large delays, and it is then necessary to impose an arbitrary allowance by agreement. The weighing of hot wirebars does not seem to cause any appreciable error, the rising air currents being negligible. Weighing in the wind is more serious, and scales should always be well protected.

Wind does not cause as much trouble in a refinery as in a smelter, owing to the nature of the material handled. If the atmosphere were absolutely quiet, however, it is conceivable that the fume losses from stacks would settle down within the confines of the plant. Dust collected from the roofs of the buildings is always high in grade although very small in quantity. A sample of dust swept up near a refinery furnace building quoted by Mr. Addicks ran 65·81% Cu, 49·8 oz. per ton Ag, and 3·41 oz. per ton Au.

A refinery is always subject to losses by pilfering, and a thorough system of patrol, passes, etc., together with a policy of prosecution of all cases detected, is necessary to hold this in check. Copper is easy to sell as junk, and systematic carrying away of small quantities in lunch pails, etc., may run into surprising amounts. In the silver refinery, it is customary to bond the employee, and to have a double set of dressing rooms with different clothes for work and for outside wear, the men passing stripped before a watchman from one room to the other. One assistance in the detection of silver and gold thefts lies in the fineness of the products. When a man offers 999 silver or 24 carat gold for sale he at once arouses suspicion.

Although the day has passed when electrolytes were purified by running a proportion to the sewer at regular intervals, there is still plenty of opportunity for loss in the handling of solutions. It is difficult to keep the electrolyte with its free sulphuric acid confined to the circulating system on account of tank leaks, overflows, etc., and it is even more difficult to build a permanent water-tight acid-proof floor under these tanks. Some of the earlier refineries suffered severely from such losses, and at one plant it was possible to dig a well anywhere in the vicinity and pump out water which gave a profitable copper recovery when passed over scrap iron. A good way to keep track of losses from this and similar sources is to keep a careful record of sulphuric acid movements in the solutions. Serious acid losses point at once to equivalent copper solution losses. In plants where waste liquors are worked up by cementation upon iron there is an additional opportunity for loss in undertreated waste liquors.

Where a plant is unpaved there is always more or less metallic material ground into the earth, and in a smelting plant the top soil becomes in time very good ore. In fact some of the smelters have been smelting this material during the recent high metal prices. In a refinery there is not the same opportunity for loss owing to the nature of the material handled, and such a loss should be negligible except in the case of solution losses and slime losses.

Mechanical losses of slime could be assigned to the several sub-headings preceding, but the matter is of sufficient importance to warrant separate discussion. Slime originates in the tank house. They are periodically sluiced down into a screening tank whence they are usually transferred by pumping to a receiving tank in the silver refinery. A certain amount is carried out in the cathodes. More or less adheres to the anode scrap when it is drawn, and is removed as thoroughly as possible by scrubbing or by high-pressure water-sprays before the scrap is sent to the anode furnace. Any carelessness here may result in wind and soil losses in transit or up the stack during melting. Tank leaks in the tank house carry considerable quantities of slime to the cellar floor. While most of this is recovered by washing the floor, some is absorbed and the floor material has to be smelted whenever extensive repairs are made. In the silver building the slimes of necessity get spilled around to a certain extent, and as boiling operations are conducted in this department the steam makes a sort of paste with them and care must be taken that all unnecessary walking in and out of this department be avoided, and that proper means for wiping shoes be provided. The shower baths used by the workmen should drain into the general wash water system. The best possible floor must be provided in this building. During some changes in one of the silver refineries some old foundations yielded 17,000 oz. of silver and 200 oz. of gold. The slimes before melting have the appearance of black mud, and it is difficult to get workmen to handle them with the care they instinctively give to the silver sponge and other metallic products produced later.

We pass now to the metallurgical losses. The first of these is the loss in the cupola slag. The anode and refining furnace operations produce a certain amount of slag due to the reaction between the metallic oxides formed during scorification in the furnace and silica and other oxides present in the furnace walls and hearth, or introduced as coal ashes blown over from the fire-box, or as clay used in luting up the doors, fettling, etc. In the old days of small furnaces constructed entirely of silicious material, from 3 to 4% of the weight of the charge was made in slag. In the large modern furnaces constructed partly or wholly of basic or neutral material and with much better fuel economy, the slag made is below 1%. Theoretically the slag should be a very small item. After a charge is melted, air is blown in sufficient to oxidize part of the copper. This cuprous oxide in turn displaces the impurities by oxidizing them and sending them into the slag. The cuprous oxide is soluble to a certain extent in the molten copper, and were no acids present, it would be theoretically possible to skim off simply these impurities with a little mechanically entangled copper. The actual slags made run about 45% copper, and must be treated in a blast-furnace with fluxes such as iron oxide and limestone to make black copper unless a smelting plant is connected with the refinery. If some sulphur is introduced into this charge, a low-grade product running about 94% copper can be made with a slag running below 1% in copper, but this gives a high operating cost in the anode furnace. If a high-grade black copper is made, it is very difficult to get a slag below 2% in copper. Taking a final cupola slag of 36% silica and neglecting the small quantity of silica introduced by the basic fluxes, this means that every ton of silica which is allowed to find its way into the refining furnace slags carries away from 56 to 112 lb. of copper in cupola slag, not counting the stack loss in this operation. It is evident therefore that this great source of loss is worthy of the most careful study, to the end that the least possible amount of slag be made at the reverberatories.

Not a great deal is known about the losses in the anode and refining furnace stacks. The recoveries in flue dust from waste-heat boilers installed in anode furnaces show some 0·07% of the copper treated, rather more of the silver and less of the gold. On the other hand, bag-house tests on the gases escaping from a high direct stack have shown less than this amount. The composition of the bullion under treatment has doubtless much to do with these losses, as the recoveries in furnaces treating cathodes are much less, due partly to less working of the molten charges and partly to the absence of volatile impurities which always promote metal losses.

As regard losses in the silver refinery stacks, the anode slimes consist of the insoluble impurities contained in the anode and run 30% to 40% in silver. The copper is mostly leached out as sulphate, and the slimes are then melted and subjected to a series of oxidizing operations until a high-grade doré is obtained. In general about 1% of the silver treated and about 0·1% of the gold is recovered by various means in the flue system, and great progress has been made in the last ten years in this practice. Until the Cottrell system of electrostatic precipitation was successfully applied to treating these gases, the opportunities for serious undetected losses were very great, and even now there is no point in a metal-loss investigation that needs more careful watching. The great difficulty is that the actual losses made are clearly discernible only after several years, as the results from single yearly inventories are always more or less clouded by anode furnace bottom absorptions which vary from year to year, and the punishment comes so long after the crime that it is very easy to be lax to the immediate benefit of apparent operating costs. Molten silver should be handled like a volatile liquid.

Cupola stack loss should be relatively small, as the operations are on a small scale and the charge is in reasonably good physical condition. A proper dust-chamber should be installed, however.

The loss of silver and gold in outgoing copper is a perfectly definite one, shown by daily assays. In general the loss runs from 0·5% to 0·8% of the silver and gold present in the anodes. In the case of low-grade anodes this is not serious, but when rich material is being treated this loss becomes quite an item. The loss is due to slimes adhering to the cathode and is affected by the current density, the volume of circulation of the electrolyte, and the degree of refining given in the anode furnace.

Silver is lost in outgoing gold. The United States Government does not pay for the silver in gold deposited unless the fineness is low enough to require refining. In the latter case the refining charges imposed greatly exceed the costs of refining before shipment. The net result is that any silver contents are not paid for and therefore constitute a metal loss. This loss should not exceed two or three parts per thousand. Any gold in outgoing fine silver is, of course, a total loss. It should be possible to keep this loss down to 0·1 oz. per ton of silver.

Minor losses comprise values lost in any by-products sold, such as nickel sulphate, selenium, platinum, etc., and the value of assay samples sent out without credit, etc. These sources of loss are relatively unimportant but should not be overlooked.

Process margins are negative losses or gains due to receiving more metal than accounted for, or to shipping less, due to trade customs. In copper there is no assay margin, but there is a gain of about 0·07% due to the fact that wire-bar copper runs about 99·93% copper, while it is credited as 100% against incoming copper received on actual contents. In the case of silver the uncorrected combination assay allows the refiner about 2·5% margin, while on shipments of fine silver, although the assay used shows true contents, a fineness of 999 is considered a 100% delivery. With gold there is a margin of about 0·4% in the incoming bullion from the fire assay used, but no margin in the out-going fine gold.

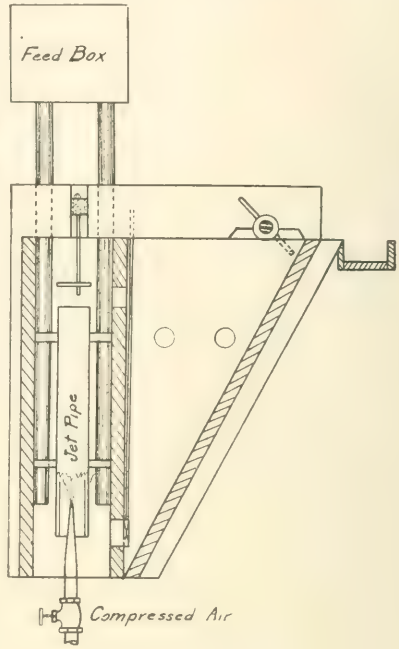
Organization of Mining Companies.—In this, one of the papers presented to the Panama-Pacivic International Engineering Congress held last year at San Francisco, Messrs. W. H. Shockley and R. E. Cranston present, following a historical introduction covering the development of company organization in mining, concrete examples of organizations worked out by three large companies, an interesting discussion of the 'Exception Principle as Applied to Graphic Charts' by H. N. Stronck, a general discussion of the principles of 'Mine Staff Organization' by L. C. Uren, and finally comment upon labour problems by the authors. Mr. Stronck points out the advantages of graphic charts in presenting figures of cost and performance and the importance of the principles that "no high-priced man should do any work that can be done by a lower-priced man" and that "exceptional cases only should be investigated by the higher officials." The first step in the application of these principles is to determine a normal. Thus in driving a particular cross-cut, it was determined that in order to fall within necessary time limits, an average progress of 4 ft. per day must be accomplished. A chart was therefore prepared for plotting with 4 ft. for a base. So long as progress did not fall below 3 nor rise above 5, reports went only to the foreman. Up to 7 and down to 2 they went only to the superintendent, but if the rate fell below 2 or rose to over 7 the matter was considered sufficiently important to warrant bringing to the attention of the general manager. Applying this principle throughout, left to the latter sufficient time free from detail for that long look ahead and for the general study of the work for which the high-priced man is assumed to be especially qualified.

Mr. Uren distinguishes three types of organization, (1) line; (2) staff; (3) committee. In the first there is a direct and single chain of responsibility such as from president through resident manager, foreman, and shift boss to workmen. In the other each worker in a particular line is responsible to a specialist in that line. In the third groups of co-ordinate officials are grouped in committees which control the work. It seldom happens, he remarks, that any one of the three systems is in use in simple form at a mine and he illustrates by diagram how the three may be combined to advantage in a small gold mine.

Mr. Foster Bain illustrates by diagram and comment how the three systems are actually combined in the case of one large company having many departments, and yet responsibility is direct and full advantage is taken of the special knowledge of each man in the organization. Similarly Mr. De Berniere Whitaker shows the actual development of the system in the case of the Juragua Iron Company and Mr. Edwin Ludlow shows how the work of the Lehigh Coal and Navigation Co. is organized.

Messrs. Shockley and Cranston close the discussion with informing comment upon relations with employees, unions, strikes, scientific management, sociological departments, and the employment of men.

Wyman's Flotation Cell.—In the *Mining and Engineering World* for June 17, J. G. Parmalee describes the flotation plant at the Standard silver-lead mine on Slocan lake, British Columbia. Two years ago a Minerals Separation plant was tried on the table and vanner tailings for the purpose of recovering the blende and pyrargyrite that were mostly lost in water concentration. Owing to graphitic schist in the country-rock being occasionally mined with the ore, the plant had a tendency to choke, for the schist also floated and it would then clog the pipes. In order to keep the cells continuously clear, an undue amount of labour was required. Trouble was also experienced with the bearings of the agitators. The plant was therefore abandoned. Later, G. H. Wyman, of Spokane, has erected a modified form of cell which may be described as a small Brown agitator, or Pachuca vat, with a spitzkasten at the side. There is no mechanical agitator and no pipes. Circulation is effected by means of the air-jet. The pulp passes through holes in the wooden partition between the air-jet chamber and the spitzkasten, at the top and at the bottom. The rising pulp is deflected toward the top holes by means of a baffle. Presumably the agitator cells and the spitzkasten are arranged as in James Hebbard's modification of the Minerals Separation machine, the pulp going from the first agitator cell into the top of the first spitzkasten, and out of the first spitzkasten at

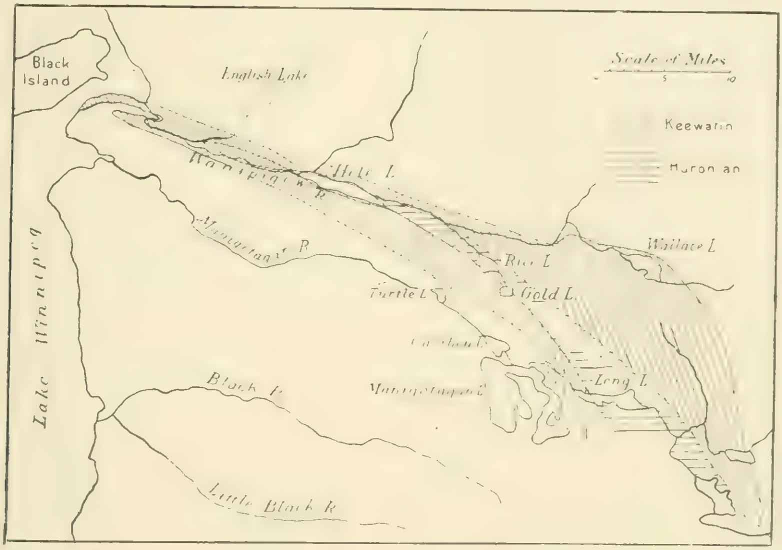


WYMAN'S FLOTATION CELL.

the bottom into the bottom of the second agitation cell; and so on through the series of cells and spitzkasten. Thus the Wyman machine may be called a Hebbard machine with air agitation instead of mechanical agitation. Further technical information with regard to this cell is desirable, and also details of results obtained.

Steel Industry in France.—Since in the old days iron was made by charcoal in small quantities and any fuel was good enough for heating puddling furnaces, iron works were not necessarily placed near coalfields and so the Creusot works were saved to France. The nearest good ore is in the minette field 200 miles away and the local coal contains 14% ash, but the historical reasons that led to founding the Creusot works are reinforced now by strategic reasons for keeping them where they are, according to H. H. Campbell writing in *The Iron Age*. He notes further that France has a large deposit of good iron ore on the Eastern frontier and a fair bed of coal, though the latter does not supply enough fuel for the needs of the country. Railroad management is bad, and in the past labour has shown no willingness to work hard even for larger wages. Capital has feared socialistic taxation, and the heavy investments abroad have taken the form of Government loans rather than industrial investments. They have therefore not made a market abroad for French products. However, in munition works the efficiency of French labour has increased at a rate that is only understandable on the basis of the poor work done before. French merchants are studying foreign markets, and if the war really wakes up the French people, British and American steel manufacturers will have competition to meet that is wholly new. While the outputs of Great Britain, Germany, Russia, and Austria have been growing, it is only France and the United States that in the last ten years have gained an increasing percentage of the world's output. The French proportion while still small may well become formidable.

Rice Lake, Manitoba.—Our Toronto correspondent referred in the last issue to the Rice Lake gold district in Manitoba, and mentioned that the Provincial Geologist has been sent to make an examination. We give herewith a brief account of this district, culled from an article by W. K. Harding, appearing in the *Mining and Engineering World* for May 27. Rice Lake is about 30 miles east of the southern part of Lake Winnipeg, and 100 miles north by west of the Lake of the Woods. The geology is similar to that of Northern Ontario, and the gold occurs in much the same way as at Porcupine and the Lake of the Woods districts. Keewatin rocks extend over a belt 60 miles long and from 1 to 12 miles wide. Their area is divided into two parts by an intermediate syncline of Huronian rocks. The first prospecting of which there is a record was along the Wanipigow river in 1897, when indications of gold and copper were found. The Canadian Geological Survey made an examination in the following year, and reported the rocks to be Huronian. Shortly afterward an Indian trapper discovered gold on the north shore of Rice Lake, farther east than the Survey geologists had gone. For some years he kept the discovery to himself, but eventually made a deal with a local trader, with the result that the Gabrielle claim was staked. Attempts to raise money in Winnipeg for developments met with no success. During 1914 further discoveries were made, this time near Gold Lake, about 3 miles south of Rice Lake, and the district then attracted the notice of Canadian and American engineers. Claims have been acquired at Gold Lake and at Long Lake, the latter being farther to the southeast. Prospecting shafts are being sunk at several places. In the Long Lake district copper sulphides carrying gold have been found.



THE RICE LAKE DISTRICT, MANITOBA.

Butters Filters for Treating Nitrate. — For many years the extraction of nitrate of soda from the Chilean and Peruvian nitrate deposits consisted of leaching the material in lump form and subsequent crystallization from the liquors. This process answered well enough with the high-grade material, but the recovery was low when the poorer parts were treated. The solution would not penetrate the low-grade lumps, and moreover the solution was absorbed by the barren sand and clay and serious losses were thereby caused. It was not advisable to try crushing to smaller sizes, for that would involve an increase in the amount of slime formed, which would clog percolation and hinder settlement. At this juncture, J. Humberstone, manager of the Agua Santa Nitrate Company, recognized the analogy between this problem and that which faced the early cyanide metallurgists. He approached Charles Butters & Co., who sent J. L. Mennell to investigate on the spot, with the result that in July 1915 a slime plant with a capacity of 200 tons per day was started. Mr. Humberstone gave a description of the problem and of the plant at the recent Mining Congress held at Santiago. This paper is published in the *South Pacific Mail* for May 25. The raw nitrate as it comes from the workings is crushed to pass a 60 millimetre hole, and afterwards separated by screens into coarse and fine, the latter being smaller than 6 m.m. The total amount treated per day is 1000 tons, of which 800 tons is coarse and goes to the usual leaching vats, and 200 tons is fine and goes to the Butters plant. The average content of pure nitrate is 18%, the remainder being sand and clay. The fine material is fed to a ball-mill, where it is mixed with a hot weak solution of nitrate of soda, in the proportion to 3 of solid to 1 of liquid. The solution contains about 120 grammes per litre as it enters the mill, and is enriched to about 450 grammes during grinding. It will be seen that the ball-mill does the double duty of grinding and agitating the slime. The pulp is then passed to a vat where it is again agitated, and the temperature is raised to 85° or 90° C. Here the remainder of the nitrate is removed. The pulp is then drawn through Butters filters in the accustomed way, and the strong solution afterward removed from the cakes by weaker solution, which in turn is removed by wash water. By means of the preliminary sizing of the raw material and the introduction of the filter plant, the yield of nitrate crystals has increased 50%. It is not only that the filter wins more nitrate but that the removal of the fine material for separate treatment greatly increases the efficiency of the older leaching process. The old process may be improved still more, when the removal of the fine is more completely effected.

The following figures give an idea of the improved conditions obtained :—

	Average of 4 previous half-years without filters	2nd half of year 1915 with filters.
Material treated—Spanish quintals ...	2,929,040	3,441,800
Content of Nitrate %........................	15	14·5
Nitrate produced—Spanish quintals...	214,774	316,270
Proportion of Nitrate extracted.........	7·3	9·75

The extra profit made was £13,685.

Beryllium.—A paper was read by Professor J. W. Richards before the American Institute of Chemical Engineers on June 14 on the metallurgy of the rarer metals. The author discusses the possibilities of improving the methods of extraction and the uses to which the metals may be put, provided the supplies can be increased and the prices reduced. We extract some remarks on beryllium (sometimes called glucinum), a metal that is little known at present, but which will repay research. It is white, malleable, unchanged in air, and has the low specific gravity of 1·64, so that it would be applicable for the manufacture of light untarnishable objects. Its specific heat is the highest of any useful metal, its latent heat of fusion is probably abnormally high, and its latent heat of vaporization higher than that of any element except carbon and boron. Such characteristics might give it special uses in electrical and physical apparatus. Beryllium bronzes have been produced in the electrical furnace, by the reaction of oxides of copper and beryllium with carbon. The proportion of 0·5% makes copper hard and sonorous; 1·5% makes it yellow; 5% produces a golden yellow bronze. Little is known of the mechanical characteristics of beryllium, such as tensile strength or rigidity or of the effect of admixtures of small additions of other metals. Nor is much known of the properties of its bronzes, except that they are to some extent similar to those of aluminium bronze. The sources of the metal are more plentiful than many people may suppose. In the text books we learn that it is a constituent of emerald and aquamarine, the precious forms of beryl, but we are not usually told that beryl occurs in massive form in large quantities, looking like green quartz. At Acworth, New Hampshire, there is sufficient to make a quarry. Beryl contains 14% of BeO, 19% Al_2O_3, and 67% SiO_2. The metal may be produced by reducing a halogen salt by potassium or sodium, or by the electrolysis of a double halogen salt of sodium or ammonium. Both these methods are costly and troublesome, for the formation of a halogen salt is difficult, and the halogen set free by electrolysis is destructive of the electrodes and apparatus. Professor Richards offers these remarks with the object of indicating a possible line of research in connection with a little known but interesting metal.

REVIEWS OF RECENT IMPORTANT BOOKS

The Metallography of Steel and Cast Iron. By Henry Marion Howe, lately Professor of Metallurgy in Columbia University. New York: The McGraw-Hill Book Co.; London: The Hill Publishing Co., Ltd. Price 42s. net. For sale at the Technical Bookshop of *The Mining Magazine.*

Professor Howe's reputation as one of the leading world's authorities on metallurgy, including metallography, has long been established. A few years ago he retired from the chair of metallurgy at Columbia University, New York. The retirement, however, was of a somewhat unusual kind. It was apparently with the object of enabling him to devote himself uninterruptedly to the writing of a great work on the metallurgy of iron and its alloys. We learn from his preface that this volume is only the first of a contemplated series. It is of course impossible to guess how long it took Professor Howe to write this particular volume, but it is difficult to think that it took less than five years. It is indeed remarkable than at an age when most men in similar circumstances would regard themselves as entitled to mental repose, or at any rate, relaxation, Professor Howe should set himself this truly stupendous task. If he lives to complete it, the achievement will rank with that of our own great metallurgist, John Percy.

Professor Howe is known to many of us as a most distinguished original investigator in the field of iron and steel metallurgy and metallography, but in the above volume he reveals himself also as a great teacher. Many writers of books, in giving an account of hypotheses and theories for which other workers are responsible, are content to portray them more or less in the form in which the latter have given them to the world. Not so Professor Howe. He insists on making himself for the time being not only the exponent, but also the author of the particular view he is expounding. Accordingly he has first to examine it critically, to make himself master of it, to lay bare its defects, if any, to absorb its essence, and then, so to speak, to give it a re-birth in his own language. This method strikes us not only as a proof of his extreme conscientiousness, but as having a vitalizing effect on every hypothesis or theory thus enunciated. Nothing can show better than the following quotation from the preface the spirit in which this book has been written: "The true task of the teacher is to excite thought. Hence I do not hesitate to offer such hypotheses as I can devise, not with the belief—hope should not enter into consideration—that they will endure, but with the aim of stirring others to seek the truth by destroying them." Nobody without the humility natural to a great man could have written that sentence.

Professor Howe's book leaves upon the mind an impression of its remarkable comprehensiveness. Whatever he is writing about he treats with such insight, profundity, and thoroughness, that after reading it we feel: "there is really nothing more to be said. He seems to have considered everything, and nothing could be fairer than that summary of the position to date."

The book before us consists of two nearly equal and quite distinct parts: (1) an exposition of the microscopic metallography of steels and cast irons, and (2) an extremely detailed study of the mechanism of plastic deformation. The first part consists of fourteen chapters. It opens with an introduction, and is followed by short chapters on the question of the permanence of our supply of iron, on the manufacture of iron and steel, and on the classification and nomenclature of metallurgical products. The next seven chapters deal with various aspects of the constitution of iron-carbon alloys, and their equilibria. Then follows a chapter on the phase rule, and this is succeeded by two chapters on the crystalline structure of metals. It is quite impossible within the limits of this review to give any adequate conception of Professor Howe's characteristically thorough and detailed treatment of these subjects. There is only one thing to be said, and it applies to all chapters of the book, and that is that they must be read and read critically. It is hopeless trying to read this book other than very slowly. The style is terse and compressed, and every sentence gives the impression of having been thought out carefully. The iron-carbon equilibrium diagram, so far as it is established, has often been described, but Professor Howe's exposition has invested it with a new and deeper meaning. The diagram is still far from being completely understood, and Professor Howe has wisely confined himself to those lines whose existence is firmly established. Fig. 24, illustrating the quantitative course of solidification, is novel and especially welcome, and the whole treatment of the changes that occur between the liquidus and the ordinary temperature is exceedingly fine. It is somewhat curious to find the exposition of the phase rule postponed until after that of the iron-carbon equilibrium. It looks rather as though Professor Howe were determined, so to speak, to keep the phase rule in its place, and that in his view that place is not a front one. He tells us that it is "a most remarkable and valuable generalization," but that "its misconception has brought out a flood of obscuring writings." The latter statement is perfectly correct, but nothing can alter the fact that it is absolutely impossible to understand the iron-carbon equilibrium diagram without a knowledge of the phase rule. Nay more. It cannot be denied that before the phase rule was applied to a consideration of the iron-carbon equilibrium, great confusion and uncertainty with regard to that equilibrium existed, and that its application by Roozeboom, who utilized existing data to produce the first equilibrium diagram, immediately raised the whole subject to a new level, clearing it from much of the aforesaid uncertainty and confusion, and that the numerous researches to which it has given rise have steadily contributed to this clarification, and to a deeper and more accurate knowledge of the subject. It is interesting to observe from Footnote 2, page 165, that Professor Howe was the first to adopt quenching experiments in order to gain an insight into the structure and constitution of alloys at high temperatures. This method has long become classical.

Few will be found to question his opinion that great as has been the aid which metallography has rendered to steel makers, yet it holds out even greater promise to the iron founders. The art of the latter is still "astonishingly crude." The total carbon content of automobile cylinders is said to vary from 2·52 to 4·16, and the combined carbon content from 0·3 to 0·90. It is also interesting to read on page 226 that "the value of oxygen as a constituent of cast iron is so firmly accepted that some of the most intelligent founders determine their oxygen content regularly, and apparently are guided by it in selecting their iron." This may be true of American, but we do not think it represents English practice. So far as we know there is not a single specification of iron or steel in this country that requires an estimation of oxygen, and we should have said that a method which can be relied upon to estimate the total oxygen in iron or steel is still to be found.

Passing now to that section of the book which treats of the plastic deformation of steel, it may be said at once that so far as we know this is absolutely unique. The author has brought into its scope the very modern work which centres round such expressions as slip bands, silhouettes, Beilby's amorphous theory, twins, Neumann bands, X bands, intercrystalline and transcrystalline rupture, the mechanism of fracture, ghosts, and fibre. There is no book with which we are acquainted which can compare with this in its breadth and depth of treatment, or which has brought within its orbit such a wealth of carefully digested observations. It is particularly gratifying to an English reviewer to note the extensive use made of the investigations of Stead, Beilby, and Rosenhain. Indeed the fundamental character of Beilby's theory of the amorphous state is recognized by the devotion of a complete chapter to its consideration. This is all the more noteworthy when it is remembered that none of Beilby's work has been done with iron at all, but with the metals gold, silver, and copper, which can be obtained in a state of considerable purity and which are not complicated, so far as the interpretation of results is concerned, by allotropic modifications. Professor Howe's own research contributions, designed to elucidate the mechanism of plastic deformation, have been of rare value and have greatly aided in the development of this field of knowledge. He is able therefore to write with that sense of command of a subject which is the reward of having aided in its creation. This section of the book is particularly well illustrated with photomicrographs, many of which are of remarkable excellence.

It is quite safe to say that Professor Howe's book will at once take its place as an authoritative, and indeed classical, exposition of the field of knowledge with which it deals. From whatever standpoint it is judged, it is a great book—great in its power, lucidness, balance, comprehensiveness, and pre-eminently scientific character.

H. C. H. CARPENTER.

A Textbook of Practical Hydraulics. By James Park, Dean of the Faculty of Mining Engineering at Otago University, New Zealand. London: Charles Griffin & Co., Limited. Price 12s. 6d. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The importance of hydraulic engineering to the mining engineer is unquestionable, and it is not very long ago since the great majority of important hydraulic installations would have been found connected with mining enterprises; of late years, since the development of hydro-electric schemes for power transmission and similar purposes, all categories of engineers have been compelled to devote an increasing amount of attention to hydraulics, but this still ranks as one of the subjects that no mining engineer can afford to neglect. The need of a work devoted to hydraulics, and especially to the practical side of the subject, in which the requirements of the mining engineer are more particularly considered, has for some time been felt, and the mining community will therefore welcome the appearance of Professor James Park's book on the subject. The method that he has adopted in dealing with it may be made clear by a brief summary of the various chapters into which he has divided his book. After a few chapters devoted to theoretical considerations, there are chapters on the Discharge of Pipes, Flow in Open Channels, Flow over Weirs, Construction of Pipes, Flumes, and Ditches, Construction of Dams, and Water Power and Water Prime-Movers. The theoretical section, it may be said at the outset, is decidedly the weakest portion of the book. Thus there is not even a mention of Bernoulli's law ; it is unsatisfactory, more especially for a beginner, to be compelled to take the fundamental equation for the velocity of efflux $v = \sqrt{2gh}$, for granted ; it would be far better to have inserted one or other of the proofs of this relation which are to be found in most text-books on hydraulics. Again, the subject of fluid pressure on immersed bodies has been omitted, though this is of importance in discussing the theory of erosion of ditches and river beds ; for the mining engineer it is perhaps even more important, in that it forms the basal principle upon which the whole theory of the hydraulic separation of minerals is founded. Another subject that is imperfectly dealt with is that of the measurement of the flow of water in pipes ; the Venturi meter is briefly described, but its theory is very inadequately stated, and there is no reference to the coefficients for correcting its readings. It may also be noted that the Venturi meter has been used successfully on pipes of much larger as well as of much smaller dimensions than those given by the author. The diaphragm method of measurement is not even referred to, although it is one of considerable importance ; Mr. Gaskell's paper upon this method in the Minutes of Proceedings of the Institution of Civil Engineers for 1913 should have been consulted and utilized in this connection. The Pitot tube method of measurement again is not adequately treated ; the closing paragraph concerning it is somewhat obscure, but if the statement "The principle of this apparatus is embodied in the water-gauge manometer," etc., is intended to convey that the water-gauge, so widely used in connection with the measurement of the ventilating current in mines, acts on the principle of the Pitot tube, it involves a very serious error. The water-gauge measures the static head, or difference in static pressure between the atmosphere and the conduit through which the ventilating current is flowing, and not the velocity-head due to the rate of flow in the conduit, it being the latter head and not the former that is measured by the Pitot tube.

The practical portion of the book, on the other hand, deserves a high meed of praise ; the details of the construction of flumes, pipes, etc., are clearly stated and are fully illustrated by numerous drawings, a fair proportion of which are sufficiently dimensioned to serve as working drawings in case of need. Throughout the book there are numerous and well arranged tables, that will greatly lighten the labour of anyone engaged in hydraulic calculations. The last chapter on hydraulic prime-movers is the weakest among the more practical portions ; it is perhaps doubtful whether it would not have been better to omit this altogether rather than to deal with it so superficially. The only prime mover that is at all fully described is the Pelton wheel, which is however admitted the most important as far as the mining engineer is concerned. Its construction is very well shown, but here again the theory is not properly discussed. The author contents himself with the bare statement that the "Pelton wheel gives its highest efficiency when the peripheral velocity is about 50% of the velocity of the spouting water," but he makes no attempt to show why this relation holds good, this being a defect which is typical of the book throughout. The theory of turbines is not attempted at all ; possibly the author thought that the mathematics required for a complete investigation of this branch of the subject would be beyond the powers of those for whom the book is chiefly intended ; but even within the rudimentary mathematical limits, to which he has taken care to confine himself, very much more might have been done, and for the student at any rate more knowledge is required than the author has here given.

Accordingly while unqualified praise cannot be given to a work on hydraulics in which the principles of the subject are not explained sufficiently for the needs of the average student, the practical man, who only requires results, or the engineer who has learnt the principles of hydraulics elsewhere, will find this a very useful and convenient work of reference.

HENRY LOUIS.

A Text-Book of Geology, for use in colleges, schools of science, etc., and for the general reader. Part I., Physical Geology, by Louis V. Pirsson ; Part II., Historical Geology, by Charles Schuchert. New York : John Wiley & Sons ; London : Chapman & Hall. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

When two of the most distinguished representatives of geological science in the United States, one well known for his petrological work and the other for his researches in stratigraphy, combine to write a general treatise on the subject, the reader is justified in expecting a great deal. In this instance he will not be disappointed, for we are presented with a reliable up-to-date survey of the whole ground, thoroughly readable, and well illustrated by photographs and diagrams.

Professor Pirsson's contribution is divided into dynamical and structural geology, the latter including some account of the different rock-types, sedimentary, igneous, and metamorphic, a useful chapter on ore deposits, as well as an appendix in which the more important minerals of rocks and ores are described. The author adopts as a rule the views now prevalent in the United States, but the famous quantitative classification is not mentioned. The brief account of the different rock-types presents some features that will appear strange to workers in this country. Diorite, gabbro, and dolerite are grouped together as ferro-magnesian rocks with subordinate felspar. Following the older geologists, the author distinguishes the two former by the presence of hornblende and pyroxene respectively, while the term 'dolerite' is reserved for rocks in which the ferro-magnesian silicate is undeterminable. This is, of course, quite different from our own usage of the word.

The second volume, for which Professor Schuchert is responsible, is comprehensive in character. It includes not only an account of the different stages in the earth's history from the earliest times, and of the formations that furnish the record of its later changes, but a general discussion of the nature, development, and distribution of life, while the characters of the principal groups of plants and animals are described in connection with the formations in which they first play an important part.

Professor Schuchert's story opens with a very problematic disruption of the sun by the close passage of another star, followed by the gradual consolidation of the earth and other planets from the débris. This is the planetesimal hypothesis of Chamberlin, and it is expounded here in a special article by Joseph Barrell. When "primordial geologic time" was reached, the earth was already, we are told, provided with an atmosphere and seas, and had become the abode of life, but it had not reached its full size, as it was still growing from the accretion of external fragmentary materials. Probably there is some truth in this supposition, for the earth is still receiving accessions of meteoric matter, though this is now practically negligible in amount.

The rocks of "primordial" time are, we are given to understand, now buried deep out of sight. The earliest rocks which we find in the accessible portion of the earth's crust are referred to the Archæozoic era, including the Coutchiching and Keewatin of the Lake Superior region and Laurentian intrusions that succeeded them. Then came a period of elevation and erosion, described, in accordance with a system adopted throughout, the Ep-Archæozoic interval. The remainder of the Pre-Cambrian is termed the Proterozoic, an expression already applied by Professor Lapworth to the older Palæozoic. The earlier Proterozoic includes the Sudburian deposits, the Algoman intrusions, and the Ep-Algoman interval, while the later comprises the Huronian, Animikian, and Keweenawan. Then comes the world-wide Epi-Proterozoic interval of elevation, or marine recession, which terminated with the incoming of the Cambrian period. It is unnecessary to follow the author in detail through the fossiliferous rocks. Epi-Palæozoic and Epi-Mesozoic intervals are recognized, but the major divisions retain, as a rule, their familiar names. The Carboniferous, however, is used in a wide sense, and includes the Mississippian, Pennsylvanian, and Permian, while for the Lower Cretaceous, Comanchian is adopted. Curiously enough the Quaternary is made a synonym of the Pleistocene instead of including, as it should, the Recent, as well as so much of the future as may be characterized by the continued predominance of man.

It will be news to readers on this side of the Atlantic that Murchison and Sedgwick, "fearing that the New York State geologists would soon propose a period name for equivalent formations [equivalent to the Devonian], hastened their work and in the same year, 1839, defined the period term Devonian." It may be remarked here that the alternative term, Old Red Sandstone, was first applied to the rocks of the Welsh border and not to those of the same age in Scotland, as the author appears to imagine.

The description of the geological succession in America will be one of the chief attractions of the book to the geologists of this country. Indeed, they would have preferred an even ampler and more connected account of this portion of the subject, as there is, so far as I am aware, at present no up-to-date work on the subject that entirely meets the requirements of the European student who wishes to gain a satisfactory understanding of the main features of American stratigraphy.

Each volume contains a copy of the same generalized geological map of North America, clearly printed in colours.

J. W. EVANS.

Concentrating Ores by Flotation. By Theodore J. Hoover. Third Edition. London: *The Mining Magazine*; San Francisco: *Mining and Scientific Press*. Price 12s. 6d. net.

The first edition of this book was published in 1912, and the second in 1914. The interest in the method of concentration by flotation continues to spread throughout the world, and there is still a strong demand for the original handbook of the art. During the first ten years of research and development the inventors and controllers of patents gave little information to the public with regard to the theory, the principle, or the performance of the plants. Thus the advantages of the method were not fully appreciated by mining men outside Australia and England. The issue of Theodore Hoover's book dispelled the cloud of mystery, and thereby opened a magnificent field for the process in the United States and South America. The American metallurgists have applied the process on a wholesale scale at the mines; they have carried forward the research into suitable oils; and most important of all, they have made the process a success in connection with chalcocite ores, which the earlier investigators failed to do.

In preparing a new edition of his book, Mr. Hoover has felt it impossible to discuss in anything like detail the recent American developments or the new theories put forward by American investigators, but he places before his readers a concise and helpful statement. With regard to theories he mentions the chief workers and gives their general results, with a bibliography of of their publications. The chief American modification in the plant employed is that devised by J. M. Callow, and this is described in the new edition. The American researches with the object of finding suitable frothing oils instead of the eucalyptus oil used in Australia have led to the discovery of valuable substitutes produced by the distillation of pine wood. The method of distillation adopted at the Pensacola works is described by Mr. Hoover. Selective or preferential flotation has not as yet proceeded far in America, and the art of floating one sulphide in preference to another has been developed chiefly at Broken Hill by the Zinc Corporation and the Proprietary. Mr. Hoover gives an elaborate record of results obtained by the Horwood and Lyster processes. Two other features of interest in the new edition relate to researches in connection with soluble frothing agents and to the production of bubbles by means of water jets. The above constitute the chief additions to the text in the third edition, but it should be mentioned also that the record of mines where the process is applied and of the new patents published, and the bibliography of articles in the press greatly increase the value of the book. It is not necessary on this occasion to say more in praise of 'Concentrating Ores by Flotation,' for it has already won fame as a classic.

EDWARD WALKER.

The Metallurgists' and Chemists' Handbook. Compiled by Donald M. Liddell. New York: McGraw-Hill Book Co.; London: Hill Publishing Co., Ltd. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

This is essentially a reference book of tables and data, compiled specially for the use of the student and metallurgist. As the author is a consulting metallurgical engineer, and was for some time on the editorial staff of the *Engineering and Mining Journal*, he is not only familiar with the many varied references daily required by the chemist and metallurgist, but has also been fortunate in obtaining much reliable information during his connection with the *Journal*.

The best test of the value of a book of this type is to ascertain the proportion of the constantly arising problems in which their solution is assisted, and from this point of view the book has been most successful. It seems to be a common experience of consultants that just the very information required is lacking in all the text-books and handbooks available, but reference to this work should in future lower the proportion of disappointments and save much time in busy offices.

The book contains sections on Mathematics, Price and Production Statistics, Physical Constants, Chemical Data, Sampling, Assaying and Analysis, Ore Dressing, Cyanidation, Fuels and Refractories, Mechanical Engineering and Construction, General Metallurgy and First Aid, together with a useful and comprehensive index.

The author is evidently more in his own element when dealing with ore dressing, roasting, and smelter details than when dealing with alloys and certain properties of the metals. The portions of the book dealing with ore dressing, etc., contain a mass of useful information, and on the other hand the portion dealing with alloys is rather weak, and that dealing with hardness of metals and alloys lacks a large amount of information that should have been given.

Many of the users of the book will undoubtedly consider that its value would have been enhanced by the insertion of a number of blank pages for additional notes. It can be strongly recommended as an everyday reference handbook for use in laboratory, office, and works.

C. E. BANNISTER.

TECHNICAL JOURNALS FOR THE MONTH

BRITISH.

Colliery Guardian.—*July 7:* The Liberation of Gas in Coal Mines, N. Yuvenalieff. *July 14:* American Practice in Coal-Mine Haulage; Approved Safety Lamps; British Forestry and Mine Timbers. *July 21:* Coal Shipping and Bunkering in Australia, F. J. Warden-Stevens. *July 28:* Home Office Report on Electric Signalling with Bare Wires in Mines; The British-Baum Coal-Washing Plant at Wombell Colliery.

Engineering.—*July 14:* Hydro-electric Power Station at Alfkarleby, North Sweden [continued July 21].

The Engineer.—*July 7:* Aerial Passenger Ropeway at Niagara Falls. *July 14:* Pumps for Draining the Inundated in Holland; The 'Turbine' Steam Boiler, the principle of the impulse steam-turbine being employed for equalizing the distribution of the air-supply; Rushton-Proctor's Paraffin Locomotive, suitable for light railways, mines, and quarries. *July 28:* The Production of Glass for Scientific Use, Bertram Blount; A Simple Diagram for Reducing Tacheometric Readings, F. R. Freeman; Schofield's Safety Device for Colliery Cages.

Geological Magazine.—*July:* Structure and Later Geological History of New Zealand, C. A. Cotton; Age of the Norseman Limestone, Western Australia, J. W. Gregory.

Iron and Coal Trades Review.—*July 7:* The German Steel Syndicate and Cartels, from a re-issue of Francis Walker's study of the subject published 10 years ago; Shaft Sinking at Keresley, Warwickshire, through wet strata; Maclaurin's Gas-Producer System at Glasgow; Tungsten Supplies in India. *July 14:* Division of the Product of Industry, Sir Hugh Bell; Approved Safety Lamps; Production and Use of Power and its Relation to Fuel Economy, G. Stanley Cooper. *July 21:* Electrical Winding Plant on the Koepe System at Plenmeller Colliery, Northumberland. *July 28:* Coal Resources of the United Kingdom, paper read before the South Wales Institute of Engineers, Arnold Lupton; Patent Law Reform, J. W. Gordon.

Midland Institute of Mining, Civil, and Mechanical Engineers.—*July 18:* Economical Production and Utilization of Power at Collieries, F. F. Mairet.

Mining Journal.—*July 8 and 15:* Costs and Profits of an Up-to-date Spelter Works, J. Gilbert.

Society of Chemical Industry Journal.—*May 31:* The Value of Sea-weeds as Raw Materials in the Chemical Industry, James Henrick.

South Staffordshire & Warwickshire Institute of Mining Engineers.—*July 17:* Structure of the South Staffordshire Coalfield, E. A. Newell Arber.

COLONIAL.

Australian Mining Standard.—*April 6:* A Sojourn in South Africa, V. F. Stanley Low [continued April 13, 29, May 4]; Mining Prospects at Tumut, N.S.W., L. P. Harper. *April 13:* Electrolysis of Zinc Ores, Hartwell Conder. *April 20:* Prospecting Paddy's Gully Line, Bendigo, H. S. Whitelaw; C.S.A. Group of Mines, Cobar, Government Geologist's Report. *April 27:* Wolfram and Molybdenite in the Northern Territory. *May 4:* Broken Hill Miners' Award.

Canadian Mining Institute Bulletin.—*July:* Canada's Future and on What it Depends, D. H. Browne; Need of Government Support for the Mining Industry of Alberta, J. L. Cote; Molybdenite Operations in Norway, H. H. Claudet; Training for Mine Rescue Work, Henry James; Coal Dust and How it Affects the Mines in the Crow's Nest Pass, W. Shaw; Ventilating Mines when Tipples are on Fire.

Canadian Mining Journal.—*July 1:* Prospectus of the Rognon Mines, Limited, formed to work a gold deposit at Dryden, Ontario; Iron Mines of Wabana Island, Newfoundland, J. W. McGrath; The Goodfish Lake District, Ontario; The Britannia Mining & Smelting Co., B.C.

Chemical, Metallurgical, and Mining Society of South Africa Journal.—*May:* Agricola and Miners' Phthisis, J. de Fenton, containing suggestions for improvements in Hoover's translation; Conglomerates of the Witwatersrand, R. B. Young.

Mining and Engineering Review, Melbourne.—*June:* Trent Plant for the Treatment of Slime at the Edna May Mine; The Kitchener Molybdenite Mine, Chillagoe, Queensland; New Gold Find in Papua; Flow of Air in Lead Blast Furnaces, A. W. Tournay-Hinde.

Queensland Government Mining Journal.—*May:* The Newcastle Colliery, Blair Athol, Queensland; The Gladston District, Lionel C. Ball; Recent Developments at the Bonnie Dundee Mine, Charters Towers, John H. Reid.

South African Mining Journal.—*June 3:* Reefs Southwest of Heidelberg; The Railways of South Africa, A. J. Beaton; The Rand's Largest Winding Engines; Electric Generating Stations on the Rand. *June 10:* New Miners' Phthisis Legislation. *June 17:* Industrial Development and Technical Research in South Africa. *July 1:* Rooiberg Tin-Dressing Plant; Geology of Southwest Africa—IX., P. A. Wagner; First Aid on Rand Mines, A. J. Brett. *July 10:* Research and Organization of Industry, J. A. Wilkinson.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*July:* Stoping in the Calumet and Arizona Mines, Bisbee, Ariz., P. D. Wilson; Flotation of Minerals, R. J. Anderson; Diastrophic Theory, M. R. Daly; Modern Methods of Mining and Ventilating Thick Pitching Beds, H. M. Crankshaw; Diesel Engines versus Steam Turbines for Mine Power Plants, Herbert Haas; Comparisons between Electrolytic and Two Varieties of Arsenical Lake Copper with Respect to Strength and Ductility in Cold-worked and Annealed Test Strips, C. H. Mathewson and E. M. Thalheimer; Tungsten and Molybdenum Equilibrium Diagram and System of Crystallization, Zay Jeffries;

Zircon-bearing Pegmatites in Virginia, T. L. Watson; Calculations with Reference to Use of Carbon in Modern American Blast-furnaces, discussion by A. H. Lee and N. M. Langdom; Motor Truck Operation at Mammoth Collins Mine, Shultz, Ariz., W. G. McBride.

Engineering and Mining Journal.—*July 1* (milling number): Choosing the Mill Site, E. S. Wiard; Apparatus Used in Flotation, H. A. Megraw; Use of Belt Conveyors; Don Luís Charme's Tremain Steam Stamp, M. R. Lamb; Cyaniding Copper-Bearing Ores, P. W. Gaeblein; Flotation of Flour Gold, R. W. Smith; New Types of Tube-Mill Lining, A. J. Weinig; Dewatering Table Sands and Concentrates, L. A. Delano; Notes on Flotation, R. C. Canby; Froths Formed by Flotation Oils, W. A. Mueller; Bunker Hill and Sullivan Milling Data, R. S. Handy; Belt and Bucket Elevators, A. O. Gates; Flotation in Joplin District, L. L. Wittich; Air Lifts at a Cyanide Plant, P. W. Gaebelein; Use of Oil in Flotation, H. A. Megraw; Crushing and Grinding Machinery. *July 8:* Amenities of Bolivian Mining, M. R. Lamb; Drilling and Analysis of Copper Ores, A. J. Sale. *July 15:* Yellow Pine District, Nev., L. A. Palmer; Stope Surveying at Mount Lyell; New Method of Expressing Protective Alkalinity. *July 22:* Boulder County Tungsten District, Colo., H. J. Wolf and P. P. Barbour; Operating a Small Copper Blast-furnace, A. Bregman; Nomenclature of Mining Methods, G. J. Young; Consolidated Amador Mines, L. H. Eddy.

Franklin Institute.—*July:* Some Problems in Physical Metallurgy at the Bureau of Standards, G. K. Burgess.

Iron Age.—*July 13:* Testing Fire Brick, C. S. Nesbit and M. L. Bell; Spelter, its Grades and Uses, G. C. Stone, from Amer. Soc. Test. Materials.

Metallurgical and Chemical Engineering.—*July 1:* Sources of Metal Losses in Copper Refining, Lawrence Addicks; Formation of Aromatic Compounds from the Cracking of a Gas Oil, G. Egloff and T. J. Twomey; Electro-chemical Possibilities of the Pacific Coast States as compared with those of Sweden and Norway, J. W. Beckman; The Rate of Driving the Blast-Furnace, J. E. Johnson; The Metallurgy of the Rarer Metals, J. W. Richards.

Mining and Scientific Press.—*June 24:* Fire Insurance on Mining Property, C. T. Hutchinson; Reopening Old Mines along the Mother Lode, T. A. Rickard; Cobalt, its Possible Uses, F. H. Mason; Stoping Hard Ore at Miami, Arizona, D. H. Scott; A Portable Equipment for Prospecting, L. A. Rehfuss. *July 1:* Mining Education. F. L. Garrison; Specific Gravity Method of Tungsten Analysis, J. J. Runner; Mining Around Lovelock, Nevada, P. B. McDonald; Theory of Flotation, E. H. Smith; Platinum on the Pacific Coast, T. W. Gruetter; Motor-Truck in Arizona, W. G. McBride; Copper Metallurgy at Garfield, Utah, L. O. Howard; Blasting Practice at Chuquicamata, Chile, H. W. Moore. *July 15:* Surficial Indications of Copper, F. H. Probert; Conditions in Mexico.

YEARLY REPORTS OF MINING COMPANIES

Transvaal Gold Mining Estates.—This company was formed in 1882 as the Transvaal Gold Exploration & Land Co. to acquire property at Pilgrim's Rest in the Lydenburg district of the Transvaal. In 1895 an amalgamation was effected with Lydenburg Mining Estates, and the name of the company was changed to the present title. The original pioneer who introduced the gold deposits of this district to the London investor was the late Nicol Brown. At the time of the amalgamation in 1895, Wernher Beit & Co. took control. At the present time the company owns the most important gold producing mines in the Transvaal outside the Rand. The report for the year ended March 31 shows that at the Central group of mines 135,330 tons of ore was raised and sent to the mill. Nearly half of this ore came from the Peach Tree group, a quarter from Duke's Hill South, and the remainder from the Theta, Graskop, and Brown's Hill. The yield of gold was worth £283,477, or 41s. 10d. per ton, and the working cost was £163,509 or 24s. 2d. per ton. At the Elandsdrift mine, 11,015 tons was treated for a yield of £45,717, or 83s. per ton, at a cost of £14,108, or 25s. 7d. per ton. At the Valhoek mine, 17,970 tons of ore was treated for a yield of £26,405 or 29s. 4d. per ton, at a cost of £19,649, or 21s. 10d. per ton. The total profit at the three groups of mines was £167,327, out of which £120,845 was distributed as dividend, being at the rate of 20%. Development at the Central group has disclosed ore of lower grade than usual, and much of the ground tested has proved unprofitable. The reserve has been maintained as to tonnage, standing at 406,226 tons, but the average content is lower at 9·37 dwt. as compared with 13·3 dwt. a year ago. The reserve at Elandsdrift has been fairly well maintained. At Vaalhoek the development has been unfavourable and the reserve is reported at 37,762 tons averaging 9·08 dwt. per ton. The excessive floods of a year ago caused increase in costs and loss of ground.

Shamva Mines.—This company was formed in 1910 by the Consolidated Gold Fields of South Africa and Lewis & Marks for the purpose of developing a gold deposit on Lone Star hill in the Abercorn district of Rhodesia. The metallurgical plant contains 56 Nissen stamps and 10 tube-mills. Milling started in January 1914, and the first dividend was paid in March 1915. The report for the year 1915 shows that 576,640 tons of ore was mined and milled. The yield of gold by amalgamation was 30,541 oz., and by cyanide 72,750 oz., a total of 103,291 oz., worth £435,488. In addition, cyanide slags sold for £3549. The yield per ton was 15s. 3d. The working cost was £239,840, or 8s. 4d. per ton. The dividends totalled £165,000, being at the rate of 27½%. Development of the 5th level was resumed, and it has been proved so far over a length of 260 ft. to average 27 ft. wide, with an average content of 4·9 dwt. Winzes are now being sunk with the object of opening a 6th level. The ore reserve on December 31 was estimated at 1,750,730 tons, averaging 5·44 dwt. as compared with 2,044,612 tons, averaging 5·24 dwt. the year before.

Eldorado Banket.—This company was formed in 1906 by the Rhodesian Exploration & Development Co. to acquire the Eldorado gold mine in the Lomagundi district of Rhodesia. At the time of transfer the shaft had been sunk to the fifth level. Four years ago the control passed to the Consolidated Gold Fields, and H. A. Piper was appointed consulting engineer. Dividends were first paid in 1908, and the rate of distribution averaged 30% for the next five years. Subsequently caving, the impoverishment of the parallel lode in depth, and adverse developments in the main lode, brought about less favourable results. The report for the year ended March 31 last shows that Mr. Piper's expectation that the monthly tonnage would have to be reduced has not yet been verified, as reclamation in the upper levels has provided more ore than anticipated. How long the rate of output will be maintained is not certain. During the year, 48,880 tons of ore was treated for a yield of 30,341 oz. of gold, being an extraction of 12·4 dwt. per ton. The accounts show an income of £127,817 from the sale of gold and a net profit of £61,999, out of which £45,000 has been distributed as dividend, being at the rate of 15%. The main vertical shaft is down to the 16th level, and below that, the orebody is being followed by an auxiliary shaft, started 230 ft. from the main shaft and 70 ft. on the foot-wall side of the lode. The auxiliary shaft is down 321 ft., the 17th level has been opened, and the 18th and 19th have been commenced. The ore reserve has been maintained as to tonnage, at 52,978 tons, but the average grade is down 2 dwt. to 12·1 dwt. The length of the ore-shoot on the 17th level is 100 ft., averaging 11 dwt. over 5½ ft.

Bell Reef Development.—This company was formed in 1910 to acquire a gold mine and plant in the Gwelo district of Rhodesia, not far from the Globe & Phœnix. The control passed from the Rhodesian Exploration & Development Co. in 1912 to the Gold Fields Rhodesian Development Co. The ore contains arsenic, antimony, and graphite, and in this way resembles the ore at most of the mines in the district. The first plant erected, based on amalgamation and cyaniding, was not a success, and a new method of treatment comprising roasting and all-sliming was inaugurated in February 1914. As the recovery by the new plant was not altogether satisfactory, W. B. Blyth was asked to advise and apply his experience on complex ores obtained in West Australia. The report for the year ended March 31 last shows that 41,681 tons of ore was raised and treated for a yield of gold worth £76,061. The working cost was £74,256, and after the payment of London expenses, the net loss for the year was £4106. H. A. Piper, the consulting engineer, reports the ore reserve on March 31 at 33,174 tons, averaging 9¾ dwt. as compared with 53,070 tons, averaging 10·8 dwt. a year ago. During the year the percentage of recovery increased from 82 to 88. Development has been on a restricted scale lately, and, during the year, has been confined to the 8th and 9th levels. A limited amount of ore averaging 15 dwt. over 3 ft. has been disclosed. It is intended to continue sinking below the 9th level by means of an auxiliary internal shaft and the best position from which to start is now being considered.

Prestea Block A.—This company was formed in 1903 to acquire a gold-mining property in West Africa from the Prestea and Appantoo companies. Additional property was subsequently acquired from the Appantoo company, and, later, the whole of the property of the Prestea company was absorbed. Edmund Davis is chairman, H. F. Marriott is consulting engineer, and William Crosley is manager. Milling commenced in 1906, but was suspended from 1909 to 1911 pending further developments. Additional working funds have been provided from time to time by subscription to share capital and by loan by the Central Mining & Investment Corporation and the Fanti Consolidated. The total share capital is £1,049,876. The loan of £175,000 was finally liquidated this year. The report for the year 1915 shows that 280,137 tons of ore was raised and sent to the mill. The yield of gold by amalgamation was 67,336 oz., by cyaniding concentrate 23,168 oz., by cyaniding sand 7336 oz., and by subsequent treatment of sand by sodium sulphide 356 oz., making a total of 98,197 oz. worth £417,339 or 29s. 9d. per ton milled. The percentage of recovery was 81·16%, and the remainder is accounted for as to slimes 5·49%, sand residue 12·28%, and concentrate residue 1·07%. The sodium sulphide process was devised by W. R. Feldtmann, and the details of practice were worked out by F. Wartenweiler, and it has been running since November last as an adjunct to the cyanide treatment. As regards the mine development, the rich shoot on the 8th level in the central section continues to open up satisfactorily, and its width is in places as much as 16 ft. With the object of maintaining the tonnage mined at over 25,000 tons per month, the workings on the 4th to 7th levels are being extended beyond the central section. On December 31 the reserve was estimated at 634,264 tons averaging 38s. 3d. per ton. The accounts show a working profit of £62,526, out of which £6749 was paid for research work, and £39,155 was written off for depreciation, the remainder being carried forward.

Abbontiakoon Mines.—This company was formed by Edmund Davis in 1901 as the Abbontiakoon (Wassaw) Mines to acquire property in the Tarkwa district, West Africa. Part of the property was sold to a subsidiary, Abbontiakoon Block 1, in 1903, but the two properties were amalgamated again in 1909. The first plant consisted of ball-mills and cyanide vats, but milling was suspended in 1909. A new plant consisting of stamps and tube-mills was afterward erected and milling was resumed in July 1912. To provide funds for the building of the new plant, £140,000 was advanced on loan by the Fanti Consolidated. This loan will be finally liquidated at the end of 1916. The first dividend was paid in May 1914, and for the year 1914 the total distribution was 20% on a capital of £627,310, the payment being largely out of accumulated profit. The report for the year 1915, now published, shows that 133,103 tons of ore was milled averaging 9⅞ dwt. per ton. The yield of gold by amalgamation was worth £210,994 and by cyanide £49,441, making a total of £260,435 or 39s. 1d. per ton. The efficiency of the plant is high, for only 4 grains of gold per ton is left in the residue. The net profit for the year was £51,490, out of which £31,834 has been paid as dividend, being at the rate of 5%. The ore reserve at December 31 was estimated at 522,641 tons averaging 10·18 dwt. per ton. This figure is about 100,000 less than the year before. The main shaft is being sunk to the 16th level, and at about the end of the current year development of the new ground will be commenced. S. H. Ford is the manager.

Ropp Tin.— This company was formed in 1911 to acquire alluvial tin properties south of Bukeru, Northern Nigeria. Edmund Davis is chairman, the technical staff of the Consolidated Gold Fields of South Africa are the consulting and superintending engineers, and J. Daniel is manager. Production commenced in 1912. The tin concentrate up to the present time has been won by calabashing. Plans have been in hand for some time for the treatment of the alluvium by dredging. A large tract of ground was proved by W. E. Thorne as being suitable for this method of winning. The report for the year 1915 shows that 394 tons of concentrate was recovered, and that 510 tons was shipped, part of the amount shipped being produced during the previous year and not shipped on account of the war. The net profit was £13,947, out of which £11,250 has been paid as dividend, being at the rate of 25%. A year or two ago debentures were created for the purpose of providing funds for the new treatment plant. Of these, £30,000 have been issued, but the consent of the Treasury for the issue of the remaining £20,000 has been withheld for the present. The directors arranged that this amount should be temporarily raised on loan, the lenders to take debentures eventually, with a call on shares. A second debenture, of a short term, has been created and issued, to secure £30,000. Most of the new plant has been delivered, and its erection has been commenced. The proved dredging ground is estimated to contain 11,300 tons of tin concentrate, averaging 70% metal. In addition other ground should yield 1470 tons by sluicing or calabashing.

Forum River (Nigeria) Tin. — This company was formed in 1912 by the Northern Nigeria Trust to acquire tin-alluvial ground on the Forum, Du and Bu keru rivers, Northern Nigeria. Howard Johnson reported on the properties. Laws, Rumbold & Co. are the consulting engineers, and A.W. Hooke is manager. The report for the year ended March 31 shows that 316 tons of tin concentrate was obtained, for which a credit of £29,610 is entered. The net profit was £9682, out of which £6162 has been paid as dividend, being at the rate of 10%.

Chenderiang Tin Dredging. — This company was formed in London in February 1914 to acquire the properties in Perak of two companies registered in Straits Settlements, the Chenderiang Valley Tin Dredging Co. and the Jabus Tin Hydraulic Elevators Co. A dredge built by William Simons & Co., from the designs of M. T. Nelmes Bluck, started work in April 1915. The report for the year ended March 31 last shows that the dredge treated 994,300 cubic yards for a yield of 322½ tons of tin concentrate, being an extraction of 0·72 lb. per yard. The sluicing operations with hydraulic elevator resulted in the production of 75½ tons of concentrate. The total production, 398 tons, sold for £37,910. The net profit for the year was £12,342, out of which £6937 has been distributed as dividend, being at the rate of 7½%. The working cost on the dredge, including administration expenses in Malaya but not depreciation, was 3½d. per yard.

Associated Gold Mines of Western Australia. — This company was formed in 1894 to acquire the Australia and other leases at Kalgoorlie. Dividends were paid from 1898 to 1909, amounting in all to 150% on a capital of £500,000. Subsequently the grade of the ore became much lower. Small dividends were paid for the years ended March 31, 1913 and 1914, but losses have been made since. The report for the year ended March 31, 1916, shows that 116,165 tons of ore was treated for a yield of gold worth £134,306. The working cost was £120,837, the cost of development £7641, and administration expenses £3865. The accounts showed a debit balance of £346. The yield per ton was 23s., as compared with 21s. 5d. the year before. Duncan F. McAulay, the manager, states that as has been the case during the last few years, no estimate can be given of reserves or of future prospects. There is no reserve in the strict acceptation of the term, but in all probability further supplies of low-grade ore will be available. The company has an interest in the North Thompson mine at Porcupine.

South Kalgurli Consolidated. — This company was formed in 1913 as an amalgamation of the South Kalgurli and Hainault companies, operating on the same lodes at Kalgoorlie, Western Australia. The first had been producing since 1895 and the latter since 1901. The profits of both companies were small, and the dividends were not continuous. The amalgamation was effected for the purpose of jointly exploring for further ore supplies. The report for the year ended March 31 shows that 117,190 tons of ore was treated for a yield worth £147,269. The net profit was £16,335, out of which £12,500 was distributed as dividend, being at the rate of 5%. The ore reserve was well maintained, and was estimated on March 31 at 157,617 tons averaging 6·1 dwt. per ton. The most interesting discovery was that of a cross lode at the 1060 ft. level in the Hainault. Already 3000 tons of ore from this lode, averaging 25 dwt. per ton, has been sent to the mill. John Morgan is consulting engineer, and J. M. Embleton is general manager.

Oroya Links. — This company was first formed in 1896, as the Golden Link Consolidated Gold Mines, for the purpose of acquiring the Eclipse, Croesus, and Golden Eagle leases at Kalgoorlie, West Australia. It was reconstructed in 1902 and 1907. In 1909 other mining leases and a 50 stamp mill were acquired from the Oroya Brownhill Co., and the name was changed. Small dividends were paid for 1910, 1912, 1913, and 1914. Bewick, Moreing & Co. are the general managers, and P. Fitzgerald is resident manager. The report for the year 1915 shows that 141,300 tons of ore was raised, 90,140 tons coming from the Eclipse, 41,339 tons from the Oroya North, and the remainder from the Brownhill and Block 45. The yield of gold was 34,904 oz. worth £147,554. The mill also crushed 3770 tons of tributors' ore obtained from nine different properties, and the gold extracted was worth £9273, of which £1911 accrued to the company as royalty. The accounts show a net profit of £365, which was carried forward. The reserve at the Eclipse has been fairly well maintained, and was estimated on December 31 at 158,622 tons averaging 24s. 4d. per ton. At the Oroya North only a small amount of ore remains to be extracted.

Great Fingall Consolidated. — This company was formed in 1899 by Bewick, Moreing & Co. as a reorganization of the Consolidated Murchison Mines, owning a gold mine and stamp-mill at Day Dawn, near Cue, Western Australia. Milling commenced in 1900, and for eight years large profits were made. Subsequently the orebody began to decrease rapidly in assay-value. By the advice of Dr. Malcolm Maclaren, development was undertaken below the 14th level at a point 1000 ft. north of the main shaft, and an auxiliary shaft was started there. Dividends on a reduced scale were paid from 1909 to 1913. During 1914 a loss was made owing to the partial collapse of hanging wall and the difficulty of introducing suitable packing material. The report for the year 1915 shows that milling was continued until October 31, and that during the ten months 43,706 tons of ore was treated for a yield of gold worth £71,074. The loss for the year was £9136. Very little development work was done, being confined to sinking winzes below the 18th level and opening a 19th level. Owing to the exhaustion of the company's cash resources toward the end of the year, arrangements were made whereby the West Australian Government agreed to advance sums up to £15,000 for the purpose of exploring at depth. The amount so advanced by December 31 was £1344. The ore reserve was at that date estimated at 31,010 tons averaging 35s. 4d. per ton.

Mount Lyell Mining & Railway. — This company was formed at Melbourne in 1890, to acquire a copper deposit near the west coast of Tasmania. In 1903 an amalgamation was effected with the North Mount Lyell Co. owning property adjoining. This amalgamation was advantageous from the metallurgical point of view, as the North Lyell ore high in copper and silica makes a good smelting mixture with the Mount Lyell ore low in copper and high in sulphur. Under the management of R. C. Sticht, the system of pyritic smelting has been found perfectly adapted to the treatment of this mixture of ores. The report for the half-year ended March 31 shows that the amount of ore mined was rather less than the average, owing to scarcity of labour. At the Mount Lyell mine 107,283 tons was extracted, 91,217 tons from underground and 16,066 tons from the open-cut. Of this quantity, 99,142 tons assaying 0·52% copper, 1·55 oz. silver, and 0·8 dwt. gold was sent to the smelter, and 8141 tons was sent to the sulphuric acid plant at the superphosphate works. At the North Lyell, 59,354 tons of ore was raised averaging 5·83% copper, 1·13 oz silver, and 0·1 dwt. gold per ton. Mining at the Lyell Comstock open-cut was re-started in February, and 1613 tons was sent to the flotation plant. This plant treated 1475 tons averaging $3\frac{1}{4}$% copper, and extracted 444 tons of concentrate averaging $8\frac{5}{8}$% copper. At the smelting works, 3403 tons of blister copper was produced, containing 3366 tons of copper, 200,771 oz. silver, and 4862 oz. gold. Development at the North Lyell on the 1200 ft. level gave highly satisfactory results and 167,131 tons was added to the reserve. At the Mount Lyell development on the 9th level, the limit in depth of the orebody, disclosed further ore, and also made it possible to estimate more exactly the reserve in the South Lyell. The ore reserves at March 31 were calculated at: Mount Lyell, 1,815,505 tons averaging 0·53% copper, 1·96 oz. silver, and 0·8 dwt. gold per ton; South Lyell, 464,352 tons averaging 0·4% copper, 0·2 oz. silver, and 0·8 dwt. gold; North Lyell, 1,140,341 tons, averaging 6% copper, 1·33 oz silver, and 0·1 dwt. gold. During the half-year, experiments have been conducted with a view to reducing the amount of sulphur in the pyrite before sending the ore to the blast-furnace, as the whole of the sulphur content is not required for pyritic smelting, and to save the sulphur thus removed. It is also intended to recover the sulphur from the waste gases from the furnaces if this can be economically done. The sulphur or acid thus produced will be shipped to the superphosphate works. As already recorded, the Hercules, Tasmanian Copper, and Primrose zinc-lead mines have been acquired, and tests with regard to treatment are being conducted by the Broken Hill Proprietary Co. The accounts for the half-year show a net profit of £110,559, which together with previous balances was partly written off property account, and partly transferred to reserve.

Briseis Tin and General Mining.—This company was formed in London in 1899 to acquire tin-gravel mines in northeastern Tasmania. Though the output of tin has been large, the divisible profits have not been up to expectation, the total returns having been 13s. 3d. per £1 share on a capital of £600,000. On the approaching exhaustion of the original property, adjoining lands were purchased, first the Krushka's Flat, and later the Ringarooma leases. The Wallace gold-gravel properties in northeast Victoria were also bought. The report for the year 1915 shows that 17·5 tons of tin concentrate was obtained from 5000 cubic yards of gravel sluiced at Briseis, the last of the ground to be treated; at Krushka's Flat, 306,000 cu. yd. gave 283 tons of concentrate; at Ringarooma, 236,000 cu. yd. was treated for a yield of 67·8 tons; the Mutual Hill section gave 12·8 tons from 48,000 cu. yd. The total yield was 382·8 tons. The average yield per yard at Briseis was 7·88 lb., at Krushka's Flat 2·08 lb., at Ringarooma 0·64 lb., and at Mutual Hill 0·6 lb. The concentrate was smelted at the Mount Bischoff works at Launceston, Tasmania, and the output of metal was 272·8 tons. This, together with 3·62 tons brought forward from the previous year, was sold for £47,870. The mining cost was £27,876, and £1493 was written off for depreciation of plant. For the first half of the year the drought curtailed operations. The Krushka's Flat property is approaching exhaustion. The removal of overlying hard undecomposed basalt at Ringarooma hill adds to the expense of operation. The re-diversion of the Ringarooma river will have to be taken in hand soon. At the Wallace gold properties, 1,301,500 cu. yd. was treated for a yield of £21,780 or 4d. per yard. The mining cost was £18,058 and £1923 was written off for depreciation of plant. After deducting the cost of administration and taxes, a balance of £14,006 remained, out of which £13,000 was distributed as dividend, being at the rate of $2\frac{1}{2}$% less tax.

Consolidated Gold Fields of New Zealand.—This company was formed by the Exploration Co. in 1896 to acquire from David Ziman a number of properties in the Reefton district on the west side of the south island of New Zealand. The control passed from the Exploration Co. in 1903. The directorate now includes L. Ehrlich and E. T. McCarthy. The company operates the Wealth of Nations mine, and holds controlling interests in the Blackwater and Progress companies. The report for the year 1915 shows that 25,844 tons of ore was raised and treated, yielding gold worth £41,929, or 32s. 5d per ton. The working cost was £23,884 or 18s. 6d. per ton, leaving a working profit of £18,045 or 13s. 11d. per ton. Dividends on Blackwater shares brought £9132. The sum of £10,628 was written off development account and for depreciation, and £8384 was written off the holdings in the Kotuku Oilfields Syndicate. No dividend was distributed. The development gave good results, and the ore reserve on December 31 was estimated at 36,836 tons averaging $11\frac{1}{4}$ dwt., an increase of 8782 tons in the amount and of 0·4 dwt. in assay-value as compared with the year before.—**Blackwater Mines.**—During the year 1915 the ore raised and treated was 54,643 tons, from which gold worth £115,610 was extracted, being a yield of 42s. 3d. per ton. The net profit was £24,439, and £24,999 was distributed as dividend, being at the rate of 10%. The ore reserve was estimated at 91,251 tons averaging 11·23 dwt., as compared with 104,564 tons averaging 15·5 dwt. the year before.—**Progress Mines.**—During the year 36,160 tons of ore was treated, for an extraction of gold worth £44,816. After allowance for depreciation of plant, the year's working resulted in a loss of £901. Owing to the broken nature of the ground, no exact figures can be given for the reserve, but the manager quotes 80,000 tons as a likely figure.

Burma Ruby Mines.—This company was floated in 1889 by the Rothschilds for the purpose of consolidating a number of alluvial ruby and sapphire properties at Mogok, Burma, and of working them on a systematic scale. The venture has proved to be continually disappointing of recent years, owing to this class of stone having a limited sale. Nowadays the European market is dead, and the company has to rely on the local demand. The report for the year ended February 29 shows that 1,081,093 loads of ground was washed, as compared with 1,149,777 loads the year before. The income from the sale of stones was £37,646, and the net loss for the year was £511. A year ago the loss on operation was £8433. The Kathe property, acquired a year or two ago, on the exhaustion of the better parts of the Mogok mines, is giving increasingly good yields, and a second washing plant is to be erected. A year ago we reported that the Indian Government had temporarily suspended the rental charge, and had substituted a royalty tax. The directors are now urging that this alteration shall be made permanent.

The Mining Magazine

Scientia non habet inimicum nisi ignorantem.

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REVIEW OF MINING

Introductory.—In mining circles the chief item of interest during the past month has been found in the Rand mining market. Modderfontein £4 shares have been steadily rising of late, and are being bought at £19. 10s. The reason for this appreciation is that the developments in the southern part of the ground served by the new circular shaft have proved a larger proportion of the ore to be profitable than was at one time expected. It will be remembered that in the last yearly estimate of reserves, Mr. Stuart Martin withdrew the ore in the southern ground from the total reported, as the development drifts did not give sufficiently good and sure results, and he preferred to make closer examination of the ground before arriving at any opinion. It appears that he is now satisfied that the average of the ground is good, and that he can safely add 1,000,000 tons to the reserve. The base metals have moved little during the month. The tone of the mining market has been brightened by the entry of Roumania on the side of the Allies, and by the success of the British and French attacks on the Somme. With Roumania as a foe, the Central Powers will not be able to draw on the oil supplies, and the invasion of Hungary has already deprived the Powers of possession of some of their gold mines. At one time the threat of a railway strike in the United States caused great uneasiness here, and to a less extent the proposal to retaliate in connection with the black list, for in both cases the delivery of food, cotton, metals, and munitions would have caused havoc in the Allied countries. Both of these clouds have, however, blown over.

Transvaal.—The output of gold on the Rand during August was 752,940 oz., and in other districts 28,210 oz., making a total of 781,150 oz., worth £3,311,118, as compared with 733,485 oz., 27,602 oz., 761,487 oz., and £3,232,891 in July. The number of natives employed on the gold mines at the end of August was 194,112, as compared with 192,130 at the end of July, and 196,866 a year ago. The number employed at diamond mines was 5146, as compared with 3339 at the end of July, 2105 at the end of June, and 1459 at the end of May.

Sir George Albu, in his address at the annual meeting of shareholders in the General Mining and Finance Corporation, had rather a more cheerful account to give of the position of the Corporation, and of the prospects of some of the subsidiary companies. For instance, Mr. G. A. Denny has reported favourably on the opportunities at the Cinderella. Mr. Denny is of opinion that the ore in the mine is of a slightly higher average grade than was previously estimated, and that the working costs could be lowered substantially by improvements in means of access underground. Apparently it is only the difficulty of raising funds, owing to the present financial commitments of the Corporation, that stands in the way of re-opening. West Rand Consolidated is accumulating ore reserves and funds ready for an expansion of the scale of operations when the convenient time arrives. We have already recorded the improvement in developments at Roodepoort United, and the extension of the life of the New Goch by the acquisition of ground from the City Deep.

The Meyer & Charlton still continues to be the best of the Albu group, and it contains probably the richest ground on the Rand. The developments during the quarter ended June 30 give even more remarkable results than usual. Of 989 ft. sampled on the Main Reef Leader, 824 ft. or 83% of the whole was in profitable ore, averaging 27·4 dwt. calculated over 4 ft. The reserve in the Leader at the last time of calculating averaged 18·4 dwt. over the same width.

The new plant at Modder Deep was started in June, and the capacity has already exceeded estimates. The original 75 stamps and other plant were estimated for an output of 30,000 tons per month, but eventually they treated

35,000 tons. The ten additional stamps now added were to raise the figure to 40,000; for August 41,800 tons was treated. The yield per ton during August was 38s. 7d., as compared with 37s. 2d. six months ago, and the working profit has risen from £37,163 to £46,983 during that period.

The Nigel mine in the Heidelberg district was not in the early days a member of the Witwatersrand group of mines, but of late years it has been recognized as being on the southern outcrop of the Far East Rand orebodies. Excellent dividends were paid for many years. To the economic geologists its ore occurrences have provided valuable opportunities for study. A year ago we announced that the reserves had come to an unexpectedly abrupt termination, and that the only hope left was an ore-shoot recently discovered on 11th level at No. 3 shaft. The directors now announce that the developments on this shoot have been unfavourable, and that, as the funds are running short, a reconsideration of the company's position will be necessary.

It is announced at Capetown that native labour is to be recruited for service on the docks in France. Five battalions of 2000 men each are to be sent, and though the work will not be at the front, the men will be under military direction and will be helping as effectively as though employed as soldiers. The plan has been under consideration for some time and details have been carefully thought out. There are many similar places in which native labour might be employed so as to release white men for fighting, and at the same time give the native races the opportunity many have asked for to help the Empire.

Rhodesia.—The output of gold during the month of July was worth £322,365, as compared with £333,070 in June, and £336,566 in July last year. Other products were 44,403 tons of coal, 347 tons of copper, 8756 tons of chrome ore, 452 tons of asbestos, and 94 carats of diamonds.

West Africa.—The output of gold during July is reported as worth £128,574, as compared with £127,107 in June and £140,290 in July 1915.

The Ashanti gold mines have been seriously inconvenienced by the difficulty of shipping anthracite used in the gas plant. Owing to the lack of power the tonnage treated during August fell from an average of 11,000 to 8748, and the yield from £40,000 to £35,000. The central metallurgical plant is now running on steam. Owing to the shortness of firewood supplies, it will be impossible to increase the output under present conditions, and the arrival of further consignments of anthracite is awaited. The most recent news is that a shipment of anthracite has been made, which ought to arrive at the mines by the end of this month.

Australasia.—Kalgoorlie was threatened with another strike at the end of August. At the Great Boulder, Ivanhoe, and Horse-Shoe, the Australian miners refused to work with enemy aliens, but the prompt appearance of the Minister of Mines restored the men to a more reasonable frame of mind, and operations were commenced again almost immediately. The so-called enemy aliens to which objection was made were Austrian Slavs, who had already signified their eagerness to disown any sympathy with Austria and their preference for Russian nationality, by accepting provisional nationalization papers from the Russian consul. The Minister has appointed a commission to inquire into the bona-fides of each alien.

Large amounts of 4% ore are being developed at the Pindora group of mines belonging to the Hampden Cloncurry company, and a concentrator with a capacity of 90 tons per day is being erected with a view to test the method of treatment. At the Hampden and Trekelano mines similar ore awaits treatment. Hitherto the company has smelted ore direct, the ore having an average copper content of 10%. The normal output of copper is 7500 to 8000 tons per year. The gold and silver content is small, about 5 dwt. gold and 8½ oz. silver, and, before the present premium on electrolytic copper, the profitableness of refining electrolytically was a debatable point. The company now sends the blister copper to the Port Kembla refinery, and has purchased 4000 shares for £10,000 in the owning company, the Electrolytic Refining & Smelting Co. The capacity of the refining plant has not yet been sufficiently extended to deal with the whole of the Hampden Cloncurry copper.

The Chillagoe company has undergone many vicissitudes. At the present time the debenture holders, who are in possession, are contemplating the sale of the whole property to the Queensland Government for the sum of £450,000 in cash. The company was originally formed to construct a branch railway, and to work a group of copper and lead mines in the Mungana district. More recently the Einasleigh and other copper mines were bought, and coal lands at Mount Mulligan were acquired. It was the difficulty of finding money to build a railway to the coal mines that finally placed the company in difficulties and caused an entire cessation of mining and smelting operations in 1914. The debentures issued amount to £562,000, without reckoning accrued interest, so that the holders may consider themselves fortunate in receiving a comparatively liberal offer. Under the new financial conditions, with a helpful instead of an antagonistic attitude on the part of the Queensland Government, this enterprise should have a brighter outlook.

The taxation of mines formed a subject of discussion at the half-yearly meeting of the Broken Hill Proprietary. It was announced that the amount to be paid was £100,000 greater than during the previous half-year. Details of this increase are awaited before comment can be made. The scarcity of labour is being acutely felt at the mine and mill, and the normal output of lead concentrate cannot be maintained. At the iron and steel works, the blast-furnace has been closed for repairs, but the stock of pig iron is sufficient to keep the steel furnaces occupied during the period of repair. The duplication of the blast-furnace and the coking plant is under consideration.

Cornwall.—The latest news from Cornwall is given in some detail in our Camborne letter and in our précis of yearly or half-yearly reports of mining companies. As regards the Carn Brea & Tincroft company, proposals are now being made to reduce the nominal capital of the company from £135,510 to £33,877, by writing down the par value of both the 38,607 priority and 97,733 ordinary shares from £1 to 5s. The priority shares do not, however, lose their special rights. They are entitled to all profits up to the par value of the share and then rank as ordinary shares. The company has also issued £10,500 debentures to Viscount Cliefden, one of the owners of the mineral rights, for money advanced for the erection of modern dressing plant. It is interesting to note that a magnetic concentrator is to be supplied by Fraser & Chalmers.

The depression in tin prices during the years 1914 and 1915 made it necessary for the Cornwall Tailings Co. to pick the best parts of the dumps. The richer parts of the Tincroft dump are now exhausted, and of recent months the material treated has assayed only 13 lb. of metallic tin per ton as compared with 16½ lb. a couple of years ago. The amount left in the dumps on February 29 last was estimated by Mr. Arthur Richards at 550,000 tons, of which 390,000 tons assays 9 to 10 lb. per ton and is unprofitable to treat except at a period of abnormal prices of tin; another 150,000 tons averages 12 to 12½ lb. and can be worked at a small margin of profit provided the present price is maintained; and 10,000 tons of slightly richer material is now in course of treatment. The recovery of the tin content is about 35%, a figure which well illustrates the limits of efficiency of the plant at present known to even the most expert tin dressers. We can congratulate Mr. Richards on the useful work he has done in elucidating the difficulties encountered in concentrating fine tin ores.

The recent improvements at Geevor, where rich ore has been found on the 6th level on the South Pig lode, encouraged the West Australian Goldfields Assets Company, a large holder in Geevor, to ask the opinion of Mr. R. Arthur Thomas, of Dolcoath, with regard to the position. Mr. Thomas has expressed his endorsement of the views of Mr. W. C. Williams, the manager, as to the importance of the discovery, and he also backs Mr. Williams in his recommendation to tackle other sections of the property, particularly those under Wheal Carne hill. This section is filled with water at present, but it is known to contain much promising ore.

Canada.—Forest fires have been prevalent in Ontario this summer. During July a series of fires occurred, but in only one case was a mine affected. This was the Crœsus, in Munro Township, where the surface plant was burned. A month later the Casey Cobalt was the victim, and the plant and buildings were destroyed. The Government Commissioners state that the fires were caused by settlers desirous of employing the easiest way of clearing the land. The damage done has fortunately been far less than when Porcupine was devastated five years ago.

The ball-mill continues to make friends in the Ontario mining districts, and at the Dome Mines is being gradually substituted for stamps, Mr. C. W. Dowsett, the mill superintendent, having determined that on Porcupine ore the combined cost of crushing with ball-mills and tube-mills is less than with stamps and tube-mills. The ore happens to be especially well suited to ball-mill work, being schistose and of medium hardness. Whether equally good results would follow adoption of the mill where a dense silicified ore must be crushed, the local metallurgists do not attempt to say. The first mill was placed in the Dome plant to increase capacity and because a convenient space was available. It was a Hardinge, with 8 ft. diameter, 30 in. cylindrical length, and 20 in. trunnions, driven through a flexible coupling by 125 h.p. motors. The ore to be crushed was screened through a revolving trommel with 3 in. round holes, and a product passing $\frac{1}{4}$ in. mesh with 50% of *minus* 100 mesh was expected. On this basis a tonnage of 350 was anticipated. In actual operation this has been brought to 480 with a steel consumption of 0·82 lb. per ton, of which 0·22 is from wear of the balls (measured) and 0·60 lb. (estimated) from the liners. At the McIntyre, a 6 ft. mill working on slightly harder ore shows a total steel consumption of 1·03 lb. These results are so satisfactory that the Dome Mines Co. plans to abandon stamps and substitute five mills, of which one will be held in reserve. In a cold country such as Canada, the saving in floor space is an important consideration.

Yukon.—Dredging in the Dawson district is reaching a critical stage. If the Yukon Gold Co. continues to operate all its dredges at the present rate, its accessible ground will be nearly exhausted by the end of 1917 season. The company owns additional property, but part of it is so hedged in by the Boyle and Tredgold holdings that it cannot be worked without some arrangement with them, and unfortunately the Klondyke dredging companies are at feud with each other. The claims on Hunker Creek proved unprofitable when an attempt was made to work them some years ago, and whether better results could be obtained now is uncertain. The hydraulic properties, while yielding well, can hardly last much longer unless, as is true of the dredging work, the rate of production is decreased. The Boyle company also faces an uncertain future. The season of 1915 was not profitable, owing to the wrecking of one dredge, and despite the continuation of operations up to January. This was a highly creditable performance from a technical point of view, even though the yardage was reduced about 25%. The ground being worked is rich, but there is a heavy interest charge to meet, and the company found it necessary to defer payment of its men until August this year.

United States.—Our New York correspondent gives a clear idea of the recent labour troubles on the American Railways. Another topic of special interest is the agitation among legislators for the taxation of big producers, particularly those who have reaped benefit from the manufacture of munitions. Copper producers come under this heading, and efforts are being made to impose on them a tax of 10% of the profits. As regards the future of the copper and other metal trades, the view that the demand will relax at the close of the war is not by any means general, many holding that the repair of the war's damage will bring as great a trade as the war itself. Certainly, if Germany has shot away all her copper, she will want plenty to replace it afterward.

The directors of the Treadwell group of companies operating on Douglas Island, Alaska, have decided on the terms of amalgamation of the Treadwell, United, and Mexican, basing these terms on the valuation of the properties made by Messrs. Hennen Jennings, H. C. Perkins, and F. W. Bradley. Briefly the comparative values of the three properties are estimated at 54 : 34 : 12, and the capitalization of the expanded Treadwell company will be arranged accordingly. The directors promise an early publication of the engineers' report. This will be read with unusual interest.

Chile. — The Poderosa group of copper mines at Collahuasi has not been profitable to English owners. When the purchase was made in 1908, the prospects were excellent, for the reserve was estimated at 100,000 tons of ore averaging 25% copper. The hasty distribution of a maiden dividend in 1909 left the company without the cash resources necessary for expanding the development and improving mining methods, and no further divisible profits were ever made. For the last two or three years the end of the reserve of rich ore has seemed imminent. No new ore has been disclosed in the Poderosa mine below the 7th level until just recently. Mr. J. H. Ivey now reports that in sinking a winze below the 9th level two narrow but rich shoots have been discovered. The indications are sufficiently favourable to encourage Mr. Ivey to continue sinking the winze and to develop the shoots from a 10th level. At the Rosario mine also developments have been rather more promising during the last few months.

Russia.—Mr. F. W. Baker, presiding at the meeting of the Russian Mining Corporation, announced that financial assistance for developing the Altai Concessions had been secured from an Anglo - Russian company whose name is not disclosed. It is not proposed, however, to proceed with the construction of dressing or smelting plant until after the war. The corporation is also obtaining financial and technical assistance from America in connection with the Petrograd water-supply and drainage proposition. Here again, no names are as yet mentioned, but we may presume that the American group referred to is one of the companies affiliated with the new International Corporation. The head of the latter is president of the Stone & Webster Corporation, which is widely experienced in financing and constructing public works.

France.—As is well known, the first impetus of the German army carried them over the principal coal and iron fields of France. French iron makers have had great difficulties ever since in supplying the requirements of the munition works, and long neglected sources are being brought into requisition. Shortly before the war preliminary arrangements had been made for extensive development of the carbonate iron ore deposits in Normandy by the Cail company, with which were associated the Thyssen interests of Germany. Soon after the war began the concession was transferred bodily to Creusot and big works are now nearing completion for using this ore. One of the features of the new plant will be a very modern set of by - product coke - ovens built on Belgian lines and embodying the latest and most efficient methods of preventing waste.

Spain.—It is pleasant to record that the Pena Copper Mines company has once more become a dividend-payer. The mines had been worked some time before a London company was formed in 1900 to operate them. During the early years of the London company the company was prosperous and dividends were paid. But conditions subsequently became less favourable. Then came the disagreement with the Rio Tinto company in connection with delivery of copper and ore over the latter's railway, and the necessity of constructing a new line to gain access to the port of Huelva. The company is now able to distribute £27,955 as dividend, being at the rate of 6 per cent.

Japan.—Detailed figures of production for 1915 collected by M. Isobe, director of the Mining Bureau, show that the gain in output for the year amounted to 20,920,000 yen, equal to 13½%, and bringing the total to 175,950,000 yen, exclusive of iron and steel. The percentage increases were as follows: Gold 16%; silver 5%; copper output 7%, value 37%; antimony output increase 200%, value increase 750%; zinc output 260%, value 84%; total value 11,580,000 yen. The coal output declined 8% in amount and 19% in value, mainly owing to scarcity of shipping. The Kurokana oilfields were responsible for a 11% increase in output, but the value increase was only 5%. Sulphur mining was restricted, the decrease in tonnage amounting to 3% and in value to 5%. Since the beginning of 1916, conditions in mining and metal production have continued to improve.

EDITORIAL

CIRCUMSTANCES compel us to alter slightly the order in which we present Mr. Bain's articles on South African mining. We publish this month the first of his discussions of labour problems, a subject of perennial interest on the Rand, and withhold for a later number his account of the Katanga mines.

GENERAL relief was felt the other day when Mr. Upjohn said that he would not take more than eight or nine days to finish his concluding speech for the defendants in the case of the Amalgamated Properties of Rhodesia against the Globe & Phœnix.

RUBIES and sapphires of first quality are very rare stones and are only sought by collectors and dilettante who can appreciate the difference between them and garnets and spinel. The inferior qualities, and the other stones with which they are associated, fetch little in the market. For this reason the Burma Ruby Mines company, which was floated by the Rothschilds nearly thirty years ago, has never lived up to promises. At the present time most of the output is sold to Indian buyers, and only a few hundred pounds' worth per year go direct to the London market.

NEW alloys of copper are to be expected in these days of intensive study of the metals, and we note with interest that Messrs. Frary and Temple have taken out a United States patent for alloys of copper containing not more than 1% of any of the alkaline earth metals, calcium, barium, strontium, and magnesium. It is claimed that such alloys make sound castings, harder than pure commercial copper and of high electrical conductivity. Until the results of tests are made public, judgment on these points may well be suspended, but it would appear that increased conductivity might well be the most important gain. To secure the highest obtainable electric conductivity, copper must be as sound as possible. Apparently the admixed metals are designed to remove not only any dissolved oxygen in the molten metal but also all dissolved gases. As, however, if they be left in the metal in any appreciable quantity they would themselves decrease its conductivity, they are presumably to be slagged out and hence to work only as efficient degasifiers. It will be most interesting to have comparative figures, including costs, covering the proposed and standard methods of preparing high-conductivity copper.

SPACE at our disposal does not permit the reprinting of the whole or part of an excellent paper on the Santa Gertrudis mine and mill, written by the manager, Mr. Hugh Rose, for the American Institute of Mining Engineers. Nor does the nature of the paper lend itself to treatment in our 'Mining Digest.' Its importance and high quality deserve more than the brief mention under 'Technical Journals of the Month,' so we take this opportunity of recommending readers to study it in full. And at the same time we would urge our mine managers in various parts of the world to prepare similar records of their own work and to send them for publication in *The Mining Magazine*.

ON the principle that improvements are always welcome in a wideawake community, the *Mining and Scientific Press* two years ago contracted its title to the *Mining Press*, and the *Engineering and Mining Journal* followed suit by calling itself the *Mining Journal*. A reversion to type soon occurred with our San Francisco contemporary. We have pleasure in observing that with the new volume beginning in July the *Engineering and Mining Journal* is itself once more. For ourselves we did not like those shorter titles. The alteration of name interfered with the customary abbreviations 'M. & S. P.' and 'E. & M. J.' After all an old friend is appreciated more than a new name.

IT IS not a little remarkable that the American Institute of Mining Engineers has never until this month held a session in Arizona. This neglect is now being handsomely atoned, for a whole week is to be spent during September in visiting the various copper mining and smelting centres at Globe, Bisbee, Douglas, and Phœnix in Arizona, and Santa Rita and Chino in New Mexico. Arizona at present leads the way among the states as a copper producer, having left Montana far behind, just as twenty years ago Montana outpaced Michigan. Examples of modern practice are to be found on all hands at the centres named, the reverberatory furnace, the principle of flotation, and the revival of leaching methods all affording full scope for study and investigation.

THE death of Harry Butters while serving as second lieutenant in the Royal Field Artillery in France, calls to mind the large number of young Americans who have given their services, and too often their lives, for the Allied cause. Harry Butters was the son of the late Henry Butters and the nephew of Mr. Charles Butters, both well known in British mining circles. He was a young man of force and ability, with excellent prospects in life. We can add nothing to his own estimate of the importance of what he did, as recorded in a letter to his home folks: "Never will I have an opportunity to gain so much honourable advancement to my own soul or to do so much for the cause of the world's progress, as I have here daily, defending the liberty that mankind has so far gained."

SCIENTIFIC men in this country have for long used the decimal system of weights and measures in their calculations. It is only the trading community that requires conversion. The views expressed by Mr. G. B. Hunter at the meeting of the British Association show that the manufacturers of this country are beginning to champion the reform. Mr. Hunter speaks for Swan, Hunter & Wigham Richardson, the builders of the *Mauretania*. Though not able to be present at the meeting, Sir Richard Burbidge, a characteristic representative of the London retail trades, expressed his desire to abolish the present complicated units and to start afresh on a reasonable basis. Our own confession of faith was presented to our readers in October 1915; we shall continue strenuously to support the cause.

MORE than a year ago we mentioned that the Education Department contemplated offering special facilities to Royal School of Mines students for the rapid completion of their course of studies on the conclusion of the war or on their return from the front unfit for further service. We now learn that the Governors of the Imperial College have as yet taken no action in the matter, except to indicate that probably special courses would be arranged. The Department owes it to the students to take more sympathetic interest in their future. These young men have bravely answered their country's call and have risked not only their lives but their future prospects. The least the college can do is to safeguard their chances and afford full facilities for the proper completion of their technical training. The sooner this is done, the better for the students and for the college.

INCIDENT to the great Civil War in America a half century ago, the United States government set itself deliberately to work at better development of the agricultural resources of the country. By land grants and cash subsidies a series of agricultural experiment stations were built up, borrowing somewhat from Rothamstead from time to time, which have been most influential factors in the great increase in amount and improvement in grade of the agricultural products of the country. A few years since, under the guidance of the Bureau of Mines, tentative moves were made in the direction of a similar policy as to mineral developments. Now in the midst of another great war the Washington government has determined to advance boldly along the line marked out by these prior attempts. It has been determined to establish ten new mining and metallurgical experiment stations and seven additional mine safety stations. Funds have been provided for building and equipping three of each this year and the others are to follow. Two of the experiment stations will be placed at Fairbanks, Alaska, and Tuscon, Arizona, while the third will be somewhere in the Pacific northwest. The three new mine safety stations, each of which will keep in service a modern all-steel Pullman car fully equipped with apparatus and crew for rescue and instruction work, will be at Butte, Montana, Raton, New Mexico, and Reno, Nevada. It should be remembered that all these stations are in addition to those already supported by the Bureau. The war has intensified many of the problems that the Americans have to face and among others that of federal revenue. They have wisely chosen the sure road of increasing taxes by building up the national wealth. We noted last month that the Russian authorities have the same end in view though their methods are different. If all the warring countries adopt this policy the long-run benefits of war may well off-set its drawbacks—speaking only from an economic point of view.

DETINNING is a process of considerable technical interest, and moreover it preaches a silent sermon against waste. Goldschmidts had a works at Limehouse where the tin cans rescued from the dust carts were compressed into briquettes and shipped to Essen. These briquettes were treated with chlorine for the production of tetrachloride of tin and afterward delivered to the steel-maker. Tetrachloride is a more valuable article of commerce than tin, for it is in steady demand among silk dyers, so that the reclaiming process was profitable when the recovery of tin as metal was not. Shortly after the outbreak of war, as we recorded with explanatory detail in our issue of October 1914, the works became idle, for no process for removing the tin and solder by fire methods was found commercially feasible and no supply of chlorine could be obtained. It is interesting to note that the business of the company owning the Limehouse plant, the London Electron Works, Limited, has recently been sold by the receiver for the debenture holders to George Cohen, Sons & Co., a Limehouse firm of scrap metal merchants. The new owners have apparently no knowledge of chemical engineering and no available supply of chlorine, so that there is no immediate prospect of the works being reopened. Opportunity may, however, develop later for the revival of the industry.

COMMERCIAL bodies have been inspired recently to recognize their debt to science in a practical way by undertaking to place portions of their current funds and the facilities of their works and laboratories at the disposal of students or those engaged in research. Among many worthy examples of the new spirit we may quote the action of the Brighton Corporation in giving accommodation at their electric light works to the committee of the Institute of Metals for its research in connection with the corrosion of metals by sea water. Another case is presented by the Weardale Lead Company, which successfully operates mines in the north of England. This company has decided to offer two scholarships, one to be awarded at the Armstrong College, Newcastle-on-Tyne, and one at the Royal School of Mines. The scholarships will be held by men who have successfully completed their college course and are desirous of undertaking post-graduate studies either at the Weardale mines or elsewhere. The details of the scholarships and the obligations of the holders have been prepared by Professor Henry Louis. As Professor Louis is not only the company's consulting engineer, but head of the mining department at Armstrong College, and an old Royal School of Mines man, we may be sure that the conditions have been fixed by him in sympathy with all the parties concerned. This is the first time that a mining company has founded scholarships in a direct manner at an English mining school, though post-graduate scholarships are offered by mining companies indirectly, through and with the aid of the Institution of Mining and Metallurgy. These and other recent steps toward the endowment of study and research out of the current income of the donors is to be commended. It is in striking contrast to the old system whereby a rich man did not employ his money for these purposes until he was dead and had no further use for it himself.

Why not a London Chamber of Mines?

Last month we mentioned that the Institution of Mining and Metallurgy had readily obtained the support of the directorates of mining companies in its campaign against the method of application of the excess profits tax to the profits of mining operations. The representative nature of the business men joining the Institution's committee formed to conduct this campaign is notable. Lord Harris, Sir Lionel Phillips, and Mr. F. H. Hamilton stand for South Africa, Sir Alfred Mond represents Canadian nickel interests, Mr. Robert Williams is for Central Africa, Sir Trevredyn Wynne for Burma, Mr. Henry C. Taylor for India, Mr. Leslie Urquhart for Russia, Mr. Oliver Wethered for Cornwall and Nigeria, Mr. F. A. Govett for Kalgoorlie and Broken Hill, Mr. F. W. Baker for North and South America and Russia, and Mr. Edmund Davis for West Africa and Rhodesia. It seems to us that the appointment of this committee constitutes the first step toward the formation of an organization, board, or chamber, having for its object the protection of the commercial interests of the mining industry centred in London. We have chambers of mines in Australia, South Africa, and elsewhere and efforts are being made to establish one in Cornwall. Such an institution in London has long been wanted, and has been the dream of many, but the difficulty of bringing new ideas to fruition has deadened the enthusiasm of such as have had this laudable object in view. The opportunity now presents itself for the formation of such a central chamber of mines. Let us make the committee permanent, and gradually expand it, build round it a membership among directors of mining companies, those commercially interested in the disposal of the products of the mines, and the members of the mining profession. Such an organized body would have influence in many ways, both outside and inside the business and profession of mining, and the unity of interest between these two factors of the mining industry would be better recognized. While making these suggestions and recommendations we are not unmindful of the fact that in some quarters a desire is expressed to convert this committee into a Government advisory board. We would take this early opportunity of questioning the wisdom of the policy of relegating too many of our interests to Government departments. These Government committees sit in secret conclave, and their intentions and deliberations are not matters of public knowledge. Moreover, their members are apt to become infected, unconsciously enough, with the traditional official inertia. It would be preferable for this business committee on mining to develop into an independent and combative institution, rather than degenerate into an irresponsible and indifferent Government department.

The Burden of the Mines.

On many occasions we have entered the plea against undue taxation of mining operations. Metals are won from the earth at great financial risk to the explorers, miners, and shareholders. The production of the metals, gold, iron, copper, lead, tin, zinc, and others in minor degree, yield little profit to the venturers, as compared with the eventual value of the metals to the trading and manufacturing communities. A ton of lead or tin affords a few pounds of profit to the producers, but gives the means of a thousandfold profit to the users. The present theory in this country is to tax the payee, though it is always open to argument that the ability to pay taxes is better gauged by the capacity of the individual or corporation to spend or buy. From the latter point of view the mines, being producers and sellers, are pressed to an undue extent in the matter of taxation. In fact the producers of metals are unkindly treated by politicians, who have little knowledge of the principles of trade and finance and cannot differentiate between the profits of producing and the subsequent profits of manufacture and use. The politician only considers immediate requirements, and does not look ahead.

The ordinary income tax levied on mining companies is bad enough, at the present rate of five shillings in the pound, but the excess profits tax is a further burden which in many cases may form a deterrent to production or expansion, as has already been shown in our pages. Moreover the income tax is levied on the gross profits, without proper deduction for depreciation of reserves, allocation of profits to capital account, or amortization of capital. Of the double income tax on English investments in South Africa, Australia, and elsewhere we need not write here, for sufficient has been said in the financial papers, and our Government is fully aware of the situation. All these imposts have to be met by the English-owned companies with as cheerful a front as possible, for there is no way of evading them, though representations are being made to the Government by influential committees, as recorded last month. The position of companies registered here, but controlled by foreigners and operating in countries outside the Empire, is on a different footing, for it is always open to the controllers to remove their head office, and then the foreign shareholders are not subject to British taxes. This step was taken a few years ago by the French controllers of the Mexico Mines of El Oro. Now we have the Aramayo Francke Mines deciding to move its headquarters to Geneva in order that the Bolivian controllers shall escape the British income tax.

The case of the Aramayo Francke Mines deserves detailed notice, for the company has had an interesting history and it is an important factor in Bolivian tin and wolfram production. Mining operations date back from the year 1867. For many years Mr. Avelino Aramayo and Mr. Carl Francke conducted the business privately. Mr. Aramayo and his Bolivian friends bought out Mr. Francke in 1906. Gradually most of the principal Bolivian shareholders settled in England or in other European countries. Money was then sought here for the provision of capital required for expanding the company's sphere of operations and for the improvement in mining methods and metallurgical treatment. The English connection, however, was never financially advantageous to the company. On more than one occasion the promised assistance failed, and the additional funds were eventually provided chiefly by the Bolivian owners. Wonder has occasionally been expressed that financial aid was not forthcoming in London. The explanation probably is that Mr. Aramayo never encouraged the creation of the bull points so dear to the stockbroker and preferred to consider the mining operations from a purely mercantile standpoint. The result of the comparative neglect on the part of the British investor to appreciate the Aramayo Francke shares is that Mr. Aramayo and his Bolivian friends still hold a largely preponderating interest in the company. About one-sixth of the shares are held in Germany, most of them by an endowment established by the late Mr. Francke, and by Mr. V. M. M. Braun, the company's technical representative in Germany. These German shares are now in the hands of the Public Trustee, who used their voting power in an attempt to prevent the transfer of the company's office from London to Geneva. This opposition was prompted solely by the desire not to lose a valuable source of revenue for the Treasury, for it was perfectly understood that no change of policy would be made by the new board of directors. Before the war all the wolfram was sold in Germany, for there was no other market, and also some of the tin concentrate. The company now has a contract with our Government for the supply of its wolfram output, and all the tin concentrate and the bismuth is shipped to this country. The fact that Geneva has been chosen as the new home of the company led certain suspicious critics to make references to the proximity of Geneva to Germany, and the old name of Francke was adduced as a partial confirmation. From the statement we have already made, it is clear that such agitation savours of the proverbial mare's-nest. It is right that we should make this explanation of the company's policy, and to place matters in their true light. We may suitably conclude by recording our regret that the stress of taxation has driven a well conducted company from our midst, and our hope that the incident will have some influence in the councils of the Chancellor of the Exchequer.

Education after the War.

Now that the war clouds are breaking, and Europe is no longer threatened with subjection to German militarism and kultur, Great Britain has time to ponder her future policy with regard to trade and manufactures. Modifications of fiscal and protective tariffs, restrictions of trade with the Central Powers, steps to limit German influence in our mercantile institutions, may all help to make the British Empire free from foreign competition, but these artificial aids will not be as effective in the long run as the inculcation of the principle of personal and collective effort for efficiency, and the adequate equipment of the worker with a modern mental training. That the Government now recognizes that the methods of education and research must be reorganized if the Empire is to keep pace with its rivals, is evidenced by the commencement of the endowment of research and by the appointment of commissions to investigate the educational problems of the future. One of these commissions has the duty of making recommendations with regard to the extension of instruction in modern languages, and the other will discuss the future place of science in the curriculum of a liberal education. The appointment of the two commissions is generally acceptable, especially as the members are all either experienced educationists, or practical business men who appreciate the requirements of their respective trades and the value of the possession of knowledge on a higher plane on the part of the skilled staffs. That a satisfactory solution of the problem will be attained by these commissions can hardly be doubted, so it is not incumbent on us to give expression to any views on the broader principles of education. There are, however, two suggestions in matters of detail that we may make with advantage. They may appear at first sight to be unimportant points, and they may be considered to be far away from the question of improvement in advanced education, but as they relate vitally to the early preparation of the youths of family and prospects, who will later occupy positions of influence, they seem to us to be no small matter. Our first point is that far too much of a youth's early years is occupied in holidays. At the present time all the schools for the upper and middle classes, and most of the colleges, are in session for not more than eight months in the year, and in some cases less than that. The schools take from two to two and a half months' vacation in summer, a month at Christmas, and a month at Easter. The boy of inquiring mind and earnest endeavour resents this enforced idleness. His parents probably have no time to act as substitutes for his teachers during these holidays, and it may happen that they have neither the ability nor inclination to do so. Do not let us be taken as advocates of cramming or of the theory of all work and no play. There is a wise medium in these things. The human frame and brain are in many ways like the machine, in that they do their best work when in fairly steady employment, and not left to rust at one time and to be overloaded at another. The schools under the direct control of the Board of Education have a more reasonable scale of holidays, and to that extent the children of the lower and lower-middle classes have a material advantage over their fellows born to more comfortable conditions of life. The question of the abolishment of this and other drawbacks and discrepancies in the schools for the middle and upper classes brings us to the second suggestion we have to make, which is that all these preparatory schools should be brought under the direct control of the State; in fact, that no branch of elementary education should be left to private enterprise. The owners of many of these schools often have anxious times in securing an adequate number of pupils and of suitable instructors. Then again, though these schools have to satisfy the inspectors of the Education Department on many points, the question still arises as to whether their heads have full qualifications as educators of youth. There is also the oft-recurring allegation, sometimes too true, that some schoolmasters look too much for their profit to the commissariat department, to the disadvantage of the growing boy. The school premises, their position, and their equipment are occasionally very far short of the ideal. The school-houses may be unpleasantly situated where the rents are cheap, as at the corner of two motor roads or alongside the smoky mouth of a tunnel on a busy railway, and their playing fields may be a mile or two away. Taking all these things into consideration it cannot be said that the boys whose parents are ready and willing to pay tuition fees at the rate of £5 to £20 per term always get their full money's worth. Under Government control the fees and the curricula would be more satisfactorily standardized, the schools would be better built and equipped, and the teachers would be able to devote all their energies to their own particular work without anxiety as to their future. These remarks are not of course universally applicable, for many schools, both day and boarding, have excellent endowments, but probably not ten per cent. are in these favourable circumstances, and even these more flourishing schools would find their educational opportunities improved by more direct contact with the Government authorities. We think our readers will be with us in making these recommendations which have for their object a reduction in the days of idleness and the advancement of efficiency in the schools of the upper and middle classes. Our proposals have the advantage of not involving the country in any increase of expenditure, for the scale of fees would not require much modification. The results to be obtained are that the parents who can afford to pay for their children's early education shall receive a better return for their money, and that the boys shall be given a more efficient preparatory training to fit them for their later and more serious studies.

First Aid on the Rand.

At the June meeting of the Chemical, Metallurgical, and Mining Society of South Africa, Mr. A. J. Brett gave a brief account of the experience of Crown Mines, Ltd., with first aid work. He did not point out, as we may do, that it is at the mines under his charge that the greatest progress has been made in training and equipping men for first aid work. Others have done well, but the Rand's largest producer must be acknowledged here the leader. That on the Rand generally the movement toward introducing first aid work among the miners has gone slowly is not due alone to indifference. There are experienced and capable medical officers there who are still to be convinced that any considerable extension of the work is necessary in view of the special conditions, namely, the extensive medical service maintained and the very short time that need elapse between the time of an accident and the arrival on the scene of a competent medical officer. There is, perhaps, in this attitude a little of the professional's distrust of the layman, but even the most enthusiastic advocate of first-aid training will admit that the system has its dangers, in the production among others of men who "know too much," and attempt beyond their ability. General experience is nevertheless solidly behind first-aid training and managers need only to observe caution in introducing it, in order to reap the benefits. Mr. Brett made an excellent point in suggesting that first-aid training gave an unequalled schooling in caution, and that the transition from a 'first aid' man to a 'safety first' man, was an easy and natural one. So convinced is the Crown Mines management of the value of the training from this point of view, that a general offer has been made to refund to any of the men who shall qualify for a certificate, the fees spent for lectures. As to the danger of imperfect training, Dr. L. G. Irvine, who has had a large part in organizing the work on the Rand, pointed out that a few well trained men afforded better working crews than many poorly trained. He also did well to place emphasis on skill in stopping a hæmorrhage and in performing artificial respiration, the two things that can seldom be allowed to wait even the few minutes necessary to bring a doctor to the scene. The ideal would seem to be, general information widely disseminated in order to induce caution, and advanced training to picked crews who should do the actual work of rescue and aid. In this latter direction, Crown Mines has gone far, having a well co-ordinated system of ambulance officers and special men on each shift, who receive added pay as compensation for keeping themselves in training and responding to all calls. It was our pleasure in April last to attend an underground demonstration given by one of the Crown Mines crews. A native selected by chance was told off for patient, and lay down on the floor as if with a broken back. The signal was then rung, and in short time the ambulance officer came with his kit, while the boy whose duty it is to keep track of the whereabouts of the crew, assembled them at the place of the accident. It was a pleasure to see the celerity and the quiet skill with which the patient was prepared for removal to the surface. Indeed, the work was done so gently that at the end of the operation the man was found to be sound asleep! While we will not guarantee that with a real broken back he would have been similarly peacefully slumbering, we would be quite content to trust that crew in any emergency.

The C.M. and M. Society has had a large and honourable part in stimulating interest in first aid work on the Rand. About three years ago, as a result of a safety first exhibition, the society found itself possessed of a small sum which was hardly available for its regular purposes. It was decided to use the money for a series of prizes in first aid contests among miners. It appeared shortly that there was no adequate system of training available to the men of the mines, so as a further step the South African Red Cross Society was organized to supply the need, Prof. J. A. Wilkinson becoming president and Mr. Fred Rowland, the versatile secretary of the C. M. and M., taking on the added secretarial duties of the new society. Dr. L. G. Irvine prepared 'First Aid in Mining,' of which, by the way, an excellent new edition is now ready, and a full system of instruction was arranged. Matters had just been nicely started when the war came, and the S. A. Red Cross, for the period of the war, united with the Central Good Hope Red Cross Committee to form the 'Red Cross South Africa.' Since then, war work has had first place, and from his combined headquarters Mr. Rowland has distributed impartially pamphlets and publications to scientists and packages and parcels to soldiers, while Professor Wilkinson has devoted at least as much time to comforts to soldiers as to chemistry for students. That the C. M. and M. should take honourable part in such important work for both peace and war is a striking illustration of the effectiveness of engineers in public service, when it falls to them to take part.

However well or poorly the first aid work is done a number of men must go to the hospital. It is as inevitable as that in mining a certain number of tons of ore, a definite amount of explosives, lubricants, and power will be used. The best we can do is to reduce the number as much as possible, and give the best possible attention to the men who are incapacitated. This part of the work of mining is done on the Rand most excellently. At all the mines the medical services and hospital arrangements are a credit to the industry, and the medical men on the Rand have won for themselves positions of responsibility and dignity that it is a pleasure to record. Hospitals for native workers are the rule at South African mines, and while they are not the "palaces for the sick" against which there is now a reaction, they all afford the great essentials, fresh air, sunlight, quiet, good food, and good nursing. While some of the older buildings are wooden, most of them are brick. The common form is a series of semi-detached wards connected by covered corridors to the necessary offices, operating room, and kitchens. At Kambove, in Katanga, detached brick cottages are used, each consisting of four isolated rooms accommodating two patients, but this plan has not been generally adopted. The nursing is commonly done by native orderlies, but at the Crown Mines Dr. Loesser is employing trained coloured girls, acting under the supervision of white trained nurses, or sisters as it is customary to call them in South Africa. Part of the groups maintain hospitals for white employees, and part arrange, through a system of benefit societies, for treatment at the large and excellent hospital in Johannesburg.

Safety first work on the Rand is new and not as yet so well under way, but steps have been taken and distinct progress is being made. The leadership in this has fallen to the Prevention of Accidents Committee of the Rand Mutual Assurance Company, Ltd., which among other forms of propaganda publishes *The Reef*, a lively little monthly, edited by Mr. A. Cooper-Key. Every effort is being made to catch and hold the men's attention, and the good work being done is sure to bring results in time.

It is a pleasure to dwell upon these various activities upon the Rand which show mining in its human relationships. Too often we think of our work only in terms of breaking rock and hoisting ore. It is, unfortunately, a business that uses up men as well as materials, and it is far more important to prevent loss of men than loss of gold, to save human lives than to save power and supplies.

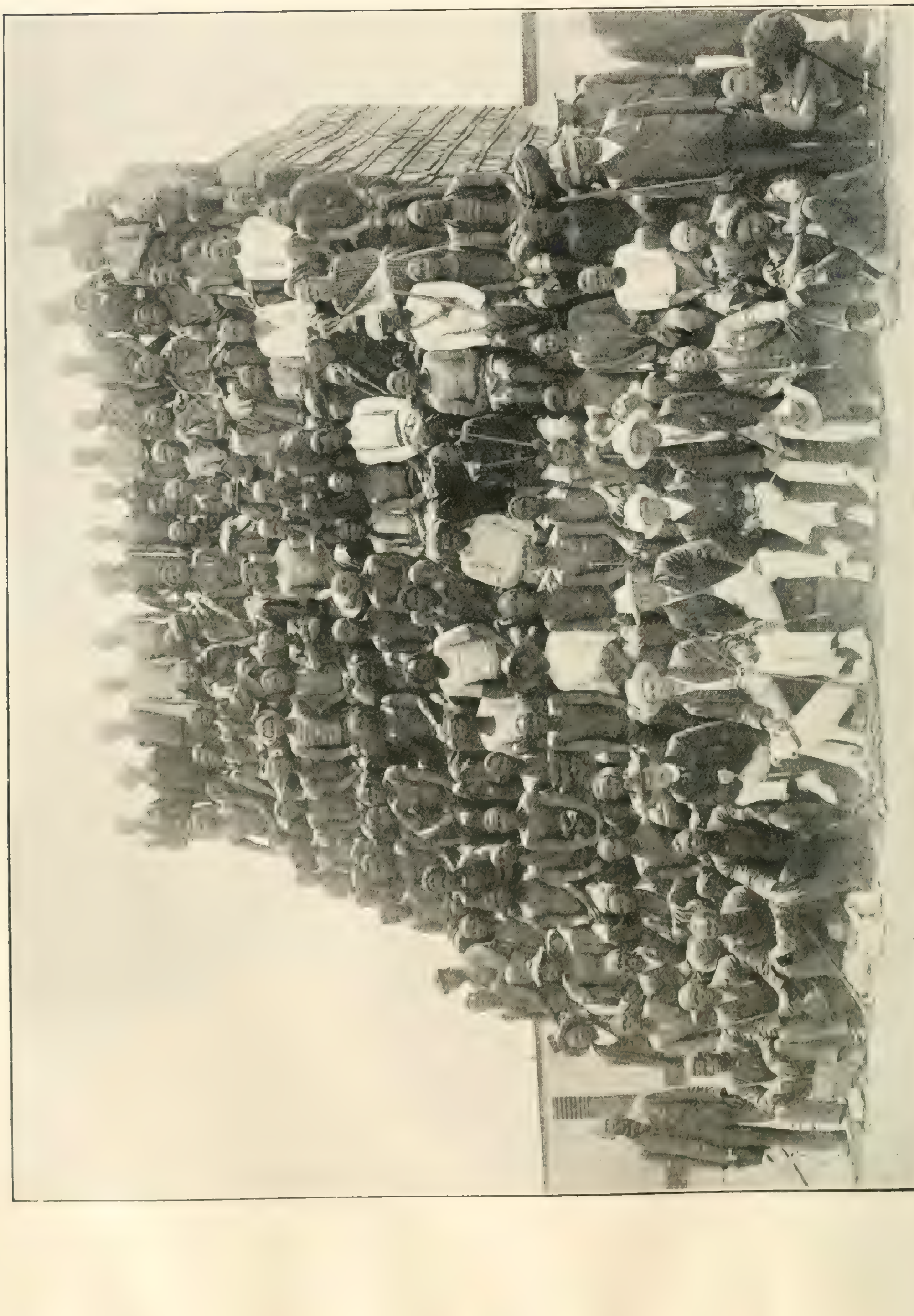
LABOUR PROBLEMS IN AFRICAN MINES—I.

By H. FOSTER BAIN

Labour forms the largest item in the cost sheets of African mines and all technical operations are conditioned by the fact that the unskilled labour is furnished by natives. The future of mining in Africa depends upon how the natives respond to the new conditions. In this, the first of three articles, Mr. Bain considers the mental attitude of the natives toward work in the mines and the influence upon them that the work exerts.

ON the Rand, as in mining generally, the largest single item in the cost of production is that paid for labour. Any consideration therefore of Rand mining must take labour problems into account first. This is especially necessary since in South Africa not only does its cost form the chief item of expense, but the amount of labour available at any time marks the practical limit to expansion, and the labour's peculiar characteristics control technical processes at every step. Indeed, whatever may be the starting point or chief interest of the visitor to South Africa, he soon finds his attention driven to labour problems. The largest single producer on the Rand is now the Crown Mines. According to the report for the year that ended December 31, 1915, this property produced and milled 2,497,000 tons of ore. The working account shows that the cost of producing and treating this ore was £2,017,791 and of this the two items, white and coloured wages, accounts for £949,078. This was only the direct labour charge. It does not include such items as native recruiting fees, sanitation charges, Miners' Phthisis Insurance Fund, outside contractors, nor does it take into account salaries and fees in the head office. In all of these, as also for power, stores and materials, there is a further labour charge concealed, but the direct charges alone amount virtually to half the cost of production. That these figures are not exceptional is shown by the facts that for the same period the total charge for white and coloured wages at Modder B amounted to £203,739 out of a total of £403,602. Similarly at the Robinson the cost was £228,448 out of £468,801; at Geldenhuis Deep £329,724 out of £685,200; City Deep £309,098 out of £690,622; at Durban Roodepoort Deep £190,000 out of £374,647; at Village Deep £272,748 out of £590,395. At all of these mines the proportion of labour would be materially increased if it was possible to show the real total now buried in other accounts. In 1915 the total tonnage from the Rand was 28,355,179. The total wages paid white labour was £7,238,704. This is nearly equivalent to 5s. per ton. The amount paid natives was £5,736,011, which is approximately 4s. 5d. per ton. The average working cost for the year according to the Chamber of Mines report was 17s. 5d. The direct labour cost therefore was 54% of the working cost. It should be remembered that this does not include the cost of housing and feeding the native labour or of recruiting it. If all such items be added, the labour cost would undoubtedly be found to equal the usual 60 to 66% of other mining districts. While, too, the particular mines cited are those for which Rand Mines acts as secretary, there is no reason to consider the figures exceptional. The cost of the labour is the big item in South African mining as elsewhere.

Contrary, too, to a general impression, due to the low wages per shift paid to natives, the labour cost per ton is not notably low as contrasted with other mines. Any such comparison is difficult to make because conditions are never the same in any two districts. The Lake Superior copper district is similar to the Rand in many particulars as to the extent of ore-shoots, depth of workings, angle of slope. Part of the stopes are of the same width as on the Rand, though the average is wider. In 1912, mining 11,000,000 tons of ore in this district involved payment of about $12,000,000 in wages or not far from 4s. 6d. per ton, which was at the same time equal to about 50% of the total cost of production. There are of course many mines where stoping conditions differ more markedly from those on the Rand in which labour costs are lower per ton than at Johannesburg, as there are also districts in which they are higher. It seems reasonably clear, however, that low native wages has not resulted in notably low working costs, though the ratio of labour cost to total cost is somewhat below the probable average. The reason for the disappointingly high labour cost lies in the low efficiency of the native labour, the large amount of supervision that it requires, and the high prices paid to the white workmen and staffs. These matters of detail will be considered further on. It is sufficient here to point out that whereas in numbers the white labourers are only as 1 to 8 or 10 of the blacks, the total wages paid them is larger than that paid to the natives.



A Representative Group of Rand Labourers with Native Police and Compound Officials.

Roughly 10% of the men absorb over 50% of the pay. In 1915 the Transvaal gold mines paid for labour as below:

Salaries	£1,176,317
Wages to Whites	6,283,884
Wages to Coloured	6,041,090
Additional payments to or on behalf of White Employees on active service	92,192
	£13,593,483

The average number of coloured employees was 193,797, and of whites 21,847. It is impossible to set off here the staff from the white workmen, but this is done in the table below covering the year 1912, and taken from the report of the Dominions Royal Commission.

	Avg. No.	Total Wages.
White Employees—		
Technical staff	1,230	£739,000
Clerical staff	1,270	379,000
Other employees	21,300	6,747,000
Total	23,800	7,865,000
Natives and coloured	192 600	5,691,000
Total	216,400	13,556,000

This division of labour into two classes produces a whole range of problems not common to other mining districts, and requires separate consideration of all labour problems into those concerned with native and with white labour.

Native Labour.

That the larger part of the labour employed upon the Rand is drawn from the native tribes is generally known. The actual figures are as below:

Number of Natives Employed in the Gold Mines, 1916.

Jan. 31	209,835	April 30	199,936
Feb. 29	209,426	May 31	194,765
Mar. 31	203,936	June 30	192,809

It is possible to use this large number of raw natives in the mines because of the nature of the work. In every land mining continually absorbs enormous numbers of unskilled workers. They come to the mines without any previous knowledge of the work to be done and in a surprisingly short time they are earning full wages. There is a place for skill in mining and skilled miners are needed, but there is also a place, and a large one, for those who have only muscle and energy to sell and the way from the ranks of the unskilled to those of the skilled is usually open and soon traversed. So true is this that miners' unions the world over make no attempt to set standards of skill. Two of the major operations in mining, shovelling and tramming, require no special skill, while the third, drilling, is easily and quickly learned. Partly because of the nature of the work, and partly by historical accident, the operations are so organized that a few skilled men direct the work of many ordinary labourers. This system almost reaches its acme on the Rand, where all the rough unskilled work is done by natives. The skilled operations are reserved by law and custom for the white men. Even when the black man becomes skilled in any line he is still classed and paid as an unskilled worker.

Included in the category of natives are the representatives of many different tribes. They differ in physical stature and strength, resistance to disease, and mental attitude so much that one no sooner begins to generalize than exceptions appear on every hand. They also differ greatly in experience and in skill. In the same mine, often side by side, one finds natives who have just come from the kraal, who may in fact never have seen a white man until a short time before and to whom all the white man's ways are strange, and natives or even half-castes who have worked in the mines for years. Some of the latter are really skilled miners and it not infrequently happens that the native workman knows better how to do the work in hand than does his titular boss. These are, however, exceptions. The usual native workman is one neither wholly strange to the life of white men nor yet so familiar with them as to have acquired any special knowledge of mining. They generally have neither the skill necessary for the responsible positions in mining nor the inclination to work with that regularity and persistence that is necessary in the higher fields of mining. It is also true that they do not have any keen sense of responsibility and without that no man should be allowed to occupy a position where, as in much mining work, an irresponsible man becomes a danger to his fellow workers.

The various companies mining on the Rand or operating collieries in neighbouring districts belong to the Native Recruiting Corporation, Ltd., which is a co-operative company maintained for securing to its members an adequate supply of native labour. With it is affiliated the Witwatersrand Native Labour Association. The first named recruits labour in the British Dominions, the second draws its supplies from the Portuguese territories. The recruits, from whatever district they come, are allotted so that each mine shall have its due share of labour. What that share is has been determined by study of a general committee which fixes a complement for each mine presumed to be adequate for its work. The cost of this work is heavy. For the year 1915 the Native Recruiting Corporation and the Witwatersrand Native Labour Association expended over £755,000 for recruiting fees, administrations, inspection, and all expenses other than refunds to members. As the fiscal years of the two associations are not the same, it is impossible to quote exactly, but, neglecting volunteers and local recruits, the number of natives supplied to the mines was 130,000 to 167,000, depending upon which period be taken as the basis. The 1915 cost per recruited shift for the W.N.L.A. is given as being 2·73d. At the Geduld the actual cost per boy per month for all recruiting and repatriation expenses is as below:

	s. d.
W.N.L.A., Portuguese boys	8 10
N R.C., Cape boys	9 4
N.R.C., general	9 0
Local	9 11
Volunteers	3 6

The present system is undoubtedly more economical and better for the boys than the old one of unrestricted competition for men, but the cost is high. The Dominions Royal Commission has pointed out the doubt that must always be felt of any system that involves the service of one white recruiter for every five labourers recruited per month, and has estimated that the cost of the system adds 14% to the native wages bill. The wages paid the boys varies from 2s. 9d. down and there is an agreement which regulates the maximum average paid at any mine for any one class of work. The actual average wage is about 2s., to which must be added housing and medical expenses, recruiting and repatriation costs, and a large number of less important items.

Legally the natives are in the position of contract labourers. Each native signs an agreement to work for a certain period, six, nine, or twelve months, and in return he is guaranteed certain pay, transportation to and from the mines, housing, food, medical and hospital service, and he is further entitled to compensation for injuries or for miners' phthisis if he be so unfortunate as to acquire the latter. His contract must be acknowledged before a public officer and elaborate machinery is provided to make sure that the native understands the nature of the contract, and also that he obtains all the benefits coming to him under its terms. The Portuguese officials insist that at least half his pay shall be given to him after he has returned to his native village, thereby securing him from exploitation to that extent, and also securing to the Portuguese territory a constant influx of money which is an important factor in the prosperity of the Province of Mozambique. It is but fair to state that every effort is made at the mines to protect the native from exploitation. No traders are allowed within the compounds and there, as throughout South Africa, it is a serious offence to sell liquor to a native. These efforts to protect the native workman are fairly successful. There is some illicit liquor selling and occasionally a native is defrauded by some other native who undertakes to care for his cash for him, or in some other way. The visitor, however, soon gets the impression, which is confirmed by the statements of those who know compound life well, that attempts to exploit the native are rare. He is treated well, and if he does not secure the benefit from his term of service in the mines that one might anticipate, the fault is with the native and the system rather than any general abuse of the latter by the white man.

The native of South Africa, no more than his white brother of Europe, likes work for itself. Indeed he has none of that joy in working which some white men have come to feel keenly and which most white men have to some slight extent. Work bores the native, and under the conditions of life to which he has been accustomed it has been looked upon as an unnecessary evil. The really interesting and stimulating exertions in life under native conditions were war and hunting. The white men have stopped the former and all but stopped the latter. They have furthermore killed most of the native industries by bringing in better and cheaper goods. They have broken up the tribal organizations so that whereas in the old days, the men of the tribe were congregated around the chief's kraal to extol his virtues and to evidence his might, they have now no place to go and nothing particular to do. It is true that the native treasures his cattle, and finds it entirely compatible with his dignity to herd, but even this leaves him much time since his wants are few and his women can easily cultivate enough ground to supply the family with food. Left to himself the native would find no sufficient reason for working and it has been part of the white man's problem, to supply that motive.

This has been done in part through the imposition of a hut tax whereby the head of each kraal pays an annual cash tax with a supplementary increase for each additional wife in polygamous families. Incidentally one may add that this supplementary tax seems to be designed less from any highly moral purpose of discouraging polygamy than because each additional wife means more land under cultivation and indirectly therefore the hut tax is a land occupation tax. The justification for the hut tax is the benefit that white rule has brought to the country. The native now has a peace and security of life and property that he never knew before. Native wars have been stopped though it is far from certain that the natives look upon this as an unmixed blessing, since war was the highest form of sport they had under old conditions as well as the readiest means of securing additional territory and wealth for the tribe, and the native is before all else a communist. Property is, however, more secure and, in the form of cattle, a native values property. The cattle are now not only protected from raiding, but the introduction of dipping and other methods of fighting cattle diseases has been of great benefit to the natives. It is impossible for the white men to protect their own cattle without at the same time protecting those of the native. As a result the native herds are increasing at a rate which is becoming a real problem in some parts of the country, since a native looks upon it as a sacrifice of capital to sell cattle and prefers instead to go without the profits of sale and see the herds increase. To police and quarrantine the country is expensive, and it is not unfair that the native should be required to pay a portion of the cost, hence the hut tax. With all his indifference to much that white men hold dear, the native shows no marked disposition to evade his tax. As a communist he accepts readily a burden exacted by the state and he is always anxious to have the money ready against the time of payment. This is one of his needs for cash.

A second concerns the much misunderstood "purchase" of a wife or wives. Under the native system the wife is the one that cultivates the soil. This was a reasonable enough arrangement (the more so since the husband milked the cows) in the old days of constant warfare, and judging from the looks of most native fields, the amount of work a native woman does is not a severe tax on her energy. However that may be, a woman is an asset to a native, and when she marries it is customary for the bridegroom to make a present of cattle or cloth to his bride's father. In a sense this is to indemnify the father for the loss of a worker, and a form of recompense for the cost and trouble of bringing the girl up. It is also a deposit during the good behaviour of the girl. Under certain conditions it is permissible for a man to send his wife back to her father and demand return of the 'lolobo.' This gives the wife's folks a keen and practical interest in securing harmony and good will in the son-in-law's family instead of the reverse, as sometimes happens in more civilized lands. Whatever the social uses of the 'lolobo,' the fact that it must be paid involves the native from time to time in the necessity of finding cash and this is the second factor which impels him to contract for a term in the mines.

The third factor is his growing wants. Contact with the white man is beginning to have its effect in increasing the wants of the native. This though, is a factor easy to over estimate. Even after considerable experience in the white man's ways the native shows a most surprising and disconcerting ability to limit himself to his old possessions and to live independent of white men. I heard while in Africa, of well organized tribes whose chiefs told off a certain number of boys for work in the mines in order to secure money with which to buy steam ploughs and prize bulls for the tribe, but such occurrences seem to be the striking exceptions. Generally the native is wonderfully content with his old life and remarkably willing and able to go back to it. He will go without, with much less distaste than he will labour to acquire, and in this fact lies the chief limitation to increasing the number of natives at work in the mines or the frequency of their return. Contrary to our expectations they do not become bitten deeply with a desire to possess what the white man possesses, or to live the lives of white men. I saw natives, and heard of many, who after living and working among the white men returned to their kraals to take up life where they left it, apparently wholly untouched and uninfluenced by what they had seen and experienced. Indeed it is probably correct to say that the native regards the white man as rather stupid than bright, as a foolish fellow who can do any wonderful thing, but who lives a life of no purpose wasted in doing things of no importance. One of their old kings said to a friend of mine, a white man whom he knew well "You wear shoes on your feet and you tell me that all white men do the same. You tell me that these are made from the skins of animals tanned to form leather. We go without shoes and do equally well. When we tan a skin to form leather we devote the latter to a useful purpose such as making a shield to protect a man in warfare." The plain truth is that the white man has not convinced the native that his is the better way and hence the native has no wish to follow his leadership. He obeys because the habit of obedience is strong and because, as we all know, it is the easier to humour a stupid man than argue him out of his error.

Where the native envies the white man and attempts to learn his ways it is often the result of a misunderstanding. The natives in many parts of South Africa are tremendously eager to learn to read and write. Everywhere one hears of the almost pathetic interest they take in book learning despite the fact that they never had sufficient need in their own life to develop or acquire a written language. One old chief complained to a magistrate while I was there that things had gone all wrong with his tribe. No one could get the women to work as they were all busy going to school. It was Booker Washington, I believe, who pointed out that the negro, seeing a white man sign a cheque, resolves to learn to write so that he too can make paper into money and never again have need to work. Both observation and hearsay indicate that this is as often the point of view of the South African native struggling with the alphabet as of any American negro. It is certainly true that only emergencies induce the native to accept the white man's work and pay. He does not look upon the conditions as a natural or desirable one.

When I visited the country there was an unusual supply of native labour at the mines. Boys were being put at hand drilling where machines had previously been used and both development and production were being pushed as had not been possible for years. Inquiry developed the fact that the reason lay not only in the idleness of the diamond mines but in the fact that a dry season had made living conditions hard in the native kraals. Natives were in fact coming forward as freely in areas from which the diamond mines do not draw labour as from any, and it was a general economic condition that was forcing them to work for a time in the mines. If it so happens that the rainfall next year be abundant and properly proportioned, if mealies and cattle thrive, there will be a shortage of labour at the mines, for not only does the native dislike any work, but by choice he prefers work with cattle and on farms to work in the mines. The latter pay better than do the farmers and when the native works it is because he needs cash for an immediate and pressing purpose. In far too many instances he begins by borrowing the money and he only works to extinguish the debt and because the penalty for no-performance of a labour contract is a prison where he must finally work anyway, and under an armed guard.

It is a practice, how general I am unable to say, to make substantial advances in cash to a native when he signs his contract. At the same time he is told that he will not be called up for work for some six months or more. As the need for money is immediate and the penalty of work lies in the future, the native takes the advance and signs the contract. Like most people inexperienced in business he has a very slight sense of what a future payment or performance means and his interest lies mainly in the present. The process, therefore, of getting him to work is becoming to a regrettable extent one of first getting him into debt and then enforcing payment through labour. Back in the districts far from the mines I was told by magistrates and farmers that the natives returned from their period at the mines with little if any cash. They brought some presents for their women folk, but in the main they had merely paid off an advance received and spent before they went to work. If they did appear at the kraal with money or goods, and the native does not like to come home and face his women empty handed, there was a fair chance that the money represented an advance upon another term of service contracted for on the road home from the mines. This may not be a general condition, but if not, experience with American negroes would indicate the danger that it may become so, and it is a grave danger to the future of the State if men must be led to work by first making them improvident.

From the point of view of the mines the importance of all this lies in the fact that the native does not regard work in them as either desirable or necessary and so long as it is a mere means of meeting a temporary emergency, the mines must expect to work with short service men who have neither interest in nor understanding of their work. What this means will be appreciated by any experienced manager. The cost of work where the corps of workmen dissolve each day and must each day be renewed, is enormous. According to the figures of the Native Recruiting Corporation, in the year ending June 30, 1915 the total number of natives hired on the Rand was 192,003. For the same period the total wastage, including those who were discharged, deserted, or died, was 171,148. It was also significant that of the 192,003 hired, 129,173 were obtained through the recruiting system; that is, they were induced by deliberate effort to take up the work. Only 33,239 volunteered, and 29,591 transferred from one mine to another. The larger part at least of the latter

IN THE CITIES THE NATIVE OFFERS "THE STRENGTH OF THE BULL AND THE FLEETNESS OF THE BIRD" TO THE SERVICE OF THE WHITE MAN.

represented boys who had served their term of recruitment at one mine and "took another ticket" or came to the mines from some other employment. The broad facts stand out that not only did almost the whole native force require renewing within the year, but that only 1670 of the natives employed cared enough for the wages to present themselves on the Rand of their own initiative. If the figures of the Witwatersrand Native Labour Association which covers the calendar year 1915 be taken, they are even more impressive. They show that, whereas the average number employed was 180,735, the total wastage for the year was 205,891. Each month of 1915 from $8\frac{1}{2}\%$ to $10\frac{1}{4}\%$ of the boys employed left the mines. The encouraging feature of the statistics is the steady increase in the number of natives who volunteer, and the number who return for a second or later term. Of the Portuguese natives approximately 80% of those hired are now experienced workers and the percentage continues to increase. Of the volunteers no exact figures are available.

The sources of the native labour employed by members of the Labour Association, which includes the mines on the Rand, at Barberton, the collieries, and the Premier diamond mine, are shown below:

SOURCES OF NATIVES EMPLOYED DECEMBER 31, 1915.

Province	No.	Per cent.
British		
Transvaal	16,334	8·23
Swaziland	4,926	2·48
Bechuanaland	2,963	1·49
Cape	65,492	33·00
Basutoland	12,389	6·24
Orange Free State	788	0·40
Natal	11,005	5·54
Rhodesia	498	0·25
Nyassaland	490	0·25
North Eastern Rhodesia	28	0·01
South West Africa	28	0·01
Total British	114,941	57·90
Foreign (Portuguese)	81,998	41·32
Various	13	0·01
Total	198,480	100·00

It will be seen that the big sources of supply are the Portuguese territories of East Africa and the Cape of Good Hope. Transvaal itself furnishes but $8\frac{1}{2}\%$ of the men, the native population of the high veldt being limited.

This is one reason why local applications for labour are not more numerous. The demand far exceeds the local supply and it is hardly to be expected that the natives, with their engrained conservatism, would of their own initiation go hundreds of miles to take up strange labour, even if the native, who by some emergency was forced to the course, had the money necessary for making the journey. If he had that amount of cash he probably would not go.

The second great difficulty that the employer must face after the quota of natives has reached the mine, is the fact that they are for the most part entirely ignorant of the work upon which they are to be employed. Some will be old boys and they will bring to the work a certain modicum of experience. It is, however, surprisingly little. The native learns a routine task with admirable facility, but he forgets with equal readiness. It is the universal statement that a boy returning even to the same job has to relearn much that he knew before, and it is a constant shock when visiting native kraals to see how little the boys have brought home from their experience at the mine. Probably this is in large part because the boy neither understands nor cares for the work. To him it is all purposeless if not actually foolish, so why bother to keep detail in mind ? His lack of interest in it works out, too, in unexpected and disconcerting ways, such as a disposition to toss a monkey wrench into machinery just to observe the succeeding ructions. There is also a well-grounded belief that anything which stops the work is clear gain, though when given a specific task the native works with right good will in order to finish and to return the quicker to his ease in the sunshine. At one of the Kimberley mines a long haulage was formerly controlled by electric contacts at many points so as to be stopped quickly in case of accident. The natives soon learned the system and took such persistent pleasure in stopping the trucks that the whole arrangement had to be altered. If you will think what it would it like to have your mine filled with mischievous school boys you will have some notion of one of the things which make mine bosses grow old before their time in Africa.

Still another factor entering into the matter of the labour costs on the Rand is tne ignorance of all the needs or methods of safety on the part of the great work of the employees. The native of course has no realization of the dangers by which he is surrounded or how to meet them. A rule framed for his protection is often to him nothing more than another evidence of the unexplainable foolishness of the white man, and that the accident rate on the Rand is not much higher than it is can only be attributed to the completeness of the code of rules and the unremitting care of the men in charge. Even as it is, accidents that are rare elsewhere occur with surprising frequency on the Rand. As an example one may cite "gassing," which happens on the Rand much more frequently than in metal mines elsewhere, despite the requirement of precautionary measures never heard of in other fields. In all these matters the complication introduced by language difficulties is serious. Very few natives speak English and equally rare is the white miner who speaks a native language. The medium of communication is 'kitchen Kaffir' which serves in South Africa the uses of pidgin-English in the Far East. It is a curious language, if one may call it such, and it has serious limitations. Also it is none too well understood by either the native who comes first to the mines or by many of the white men in charge. Back of that is the fact that in most instances the white man attempts to convey to the native a wholly new concept, something entirely foreign to his whole previous life, while himself almost entirely unfamiliar with the natives' point of view. The first rule of a successful teacher is to know the processes of the pupil's thought and to present material in the form and in the order in which it can be understood. This rule is constantly broken in the mines and it was, in my limited experience, the exception to find a white boss who cared what or how a native thought or who took any interest in his mental processes. In the hurry of keeping up tonnage one cannot expect close following of Froebel or Pestalozzi, but one may note that this failure of mind to meet mind is a constant depressing influence on tonnage and one not to be disregarded in considering costs.

Actually many of the miners and bosses work through interpreters or 'boss boys'; this has the disadvantage that not all boss boys are proof against the temptations to use their opportunities to make money on the side, especially if, as often happens, they are drinkers. In such cases the new boys are at times blackmailed into paying for easy jobs and not even the greatest vigilance entirely prevents this. Native languages are difficult to learn and too often the impression seems to prevail that if one only shouts loudly enough and fiercely enough the native must understand ; a not uncommon fallacy in other lands than Africa.

WINTER SLUICING AT THE LENSKOI GOLD MINES, SIBERIA

By C. W. PURINGTON AND R. E. SMITH.

The authors describe the method and plant for sluicing gold-bearing gravel mined in a frozen state during the winter months at the Lenskoi properties in the Vitim district of Eastern Siberia. Means are provided for thawing the frozen gravel, and treating it at once.

FIGURES are now available giving the yardage handled and the gold product of the Lenskoi Gold Mining Company during the period of winter mining and sluicing, namely, from October 1–14, 1915, to April 20–May 3, 1916. It should be explained that the system of washing the alluvial gold product of this company in sluices varying from 175 to 275 ft. in length was introduced less than three years ago, and has gradually supplanted the former methods of washing in trommel machines and short steep sluices known as *kulibinas*. While the long sluice was quickly recognized as an improvement in summer work, it was a question whether any form of washing could be applied in the winter. Since underground drift mining is carried on continuously throughout the year, the system resulted in the piling up of immense winter dumps of gravel containing anywhere from 20,000 to 80,000 cu. yd. each. The re-handling of material, on a quantity of 400,000 cu. yd. or more, representing the winter product, presented an expensive problem. This re-handling was necessary under the winter dump method when the gravel came to be washed in the open season. As the dumps were largely handled by horse and cart transport to washers, and loaded by pick and shovel work, there were many chances for theft of coarse gold, plainly visible in the gravel when wet.

In addition to this, portions of the winter dumps remaining unwashed up to the latter part of September, froze to such a depth that thawing was necessary before they could be excavated and loaded. Beside this the amount of gold tied up in the dumps over an average period of six months represented a considerable sum of money drawing no interest. For example, the average amount of money locked up in the winter dumps for the past two seasons, granting that no winter washing had been accomplished, would have been in the vicinity of a million pounds sterling for each year.

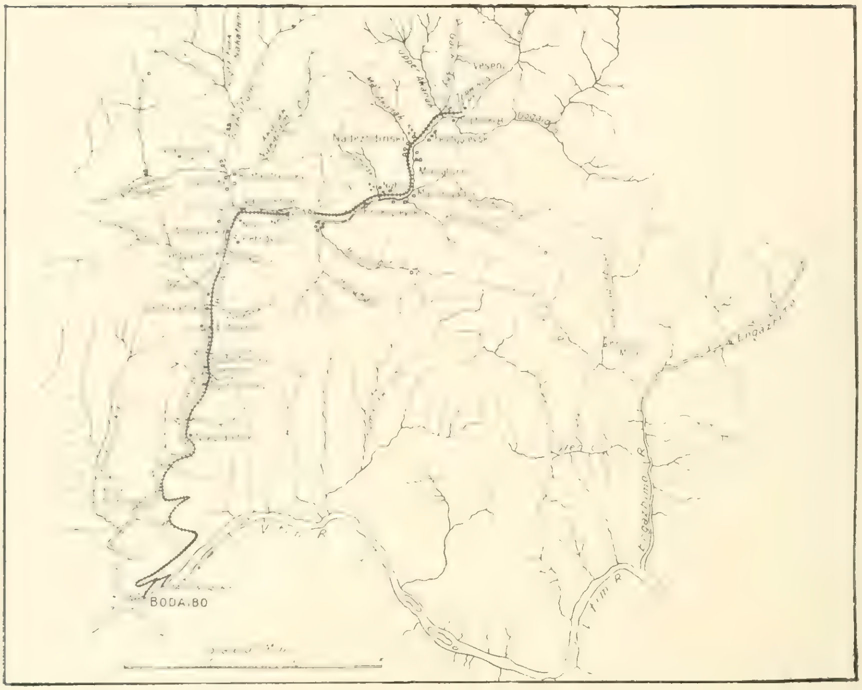
Taking all these factors together, and others which need not be touched on, it is evident that a system of all the year washing was highly desirable, if it could be effected. The Lenskoi Company had continued to operate for over four decades without solving the problem, although some attempts had been made. The Industrial Company, whose claims the Lenskoi purchased some years ago, made serious trials of winter washing with the short *kulibina* sluices, but were unsuccessful in making any considerable product. Tributers on the property do winter work by means of heating iron kettles of water, and washing in bateas or in long toms. This method is in fact pursued in many parts of the Ural and Siberia.

At Fairbanks, and some other Alaska camps winter sluicing is practiced in uncovered sluices, heated on the sides and bottom by means of live steam injected through an envelope of canvas which extends from end to end of the sluice. Meagre water supply and the difficulties of 'glacier' forming on the dump prevent any but insignificant operations.

At Lenskoi, excessively low temperatures are sometimes experienced, as in the winter of 1915 when 74° F. below zero, or 106° of frost occurred at the Feodosievsky mine for several days in January. The average temperature for that month was 33° below zero, or 65° of frost.

After experimenting at Lenskoi in the winter of 1913-14 with the old style plants, it was found that although the washing could be done continuously, the quantity washed was too small to be of much use. In 1914-15, two sluices of the Alaska type, 150 and 175 ft. long respectively, and with grade not exceeding 10% were successfully used, and the results from the larger of these two, at the main mine of the group, are below tabulated. The sluice which did the best work, namely at the Feodosievsky mine, was a re-construction of the summer sluice previously described in this Magazine*. The entire sluice was lowered so as to permit of gravity water being used, and the bucket elevator placed at the foot of the sluice, serving to raise the tailing instead of the heading as formerly. This sluice

* *The Mining Magazine*, June 1915, 'The Gold Mines of the Lena,' C. W. Purington.



Map showing the principal properties of the Lenskoi Company.

is now known as Feodosievsky No. 1 sluice.

The results were so good that in the autumn of 1915, a second similar sluice, but longer, and with improvements which will be described, was erected at the same mine. Similar sluicing units of smaller capacity were erected at the smaller mines. The results of the two seasons' work are given below in tabular form.

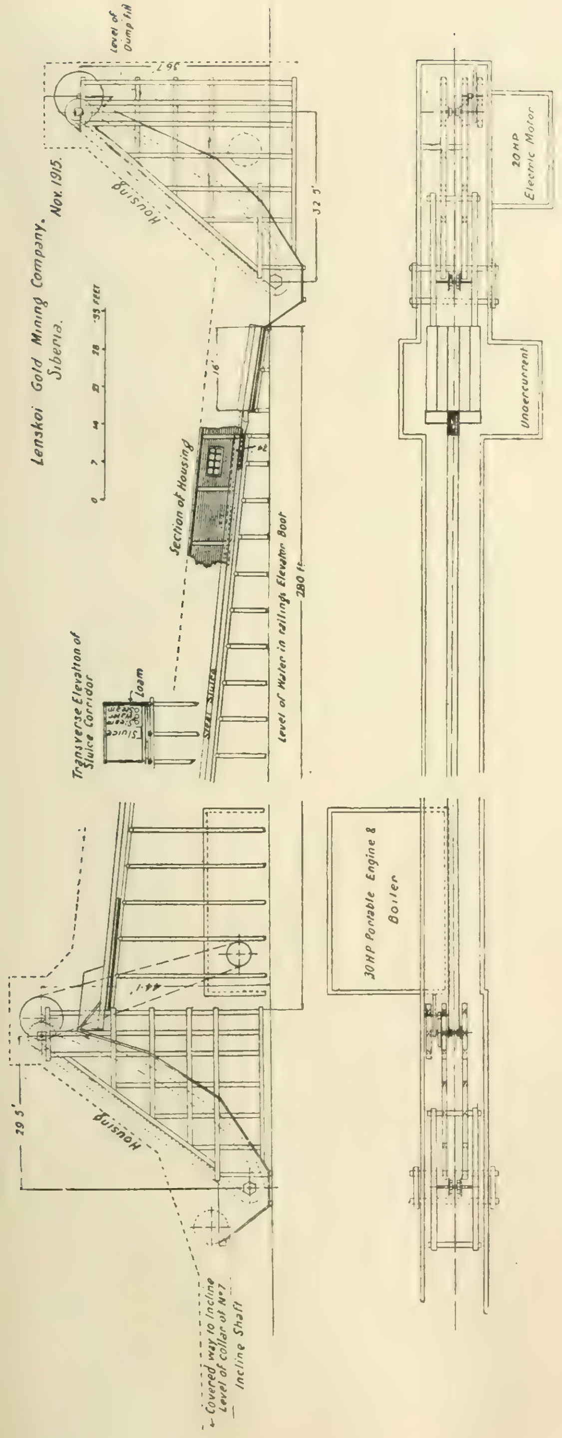
As I have fully described the physical conditions of the property and methods of drift mining in the paper referred to, I will only repeat here that the source of the gravel washed is from workings averaging 100 ft. deep, the gravel itself being mainly angular and subangular fragments of slate and sandstone, with less proportion of round granite pebbles and boulders. It is mainly unfrozen, and about 40% of the entire material would pass a one inch mesh. Sticky clay does not exist, but in the richest and main workings, some gravel adheres to the bedrock slabs, bound by an arenaceous clay cement, rendering washing somewhat difficult. Losses in sluicing, however, with both winter and summer practice, have been reduced to under 4%. From 2 to 5% of limonite and iron pyrite cubes (up to 1 inch dimensions) and nodules occur in the pay, rendering clean-ups unusually difficult. No quicksilver is used in the riffles. As much fine gold occurs with the coarse, it is contemplated to use quicksilver when retorting equipment is ready. Large boulders are left in the drifts, and nothing over 1 foot in longest dimension is ordinarily fed to the sluices.

The working season for the property is 302 days, the 63 non-working days being accounted for by holidays. The winter season consists of 162 days, and the summer 140. As the winter season varies from year to year by a few days, an average of 170 days is assumed in the calculations.

The Feodosievsky mine referred to is the principal operation, and is situated 45 miles northeast of Bodaibo, at the terminus of the Lenskoi narrow gauge railway. The remainder of the product comes from mines in the vicinity, situated within a radius of 20 miles.

Winter Season. 170 Working Days (October 14–May 3).

	1914-15	1915-16
Feodosievsky:		
Cubic yards washed	74,900	137,500
Bullion produced, oz.	73,993	120,706
Money value	£276,160	£450,500
Recovery per cubic yard	73s. 9d.	65s. 7d.
Big Chanchik:		
Cubic yards washed	—	40,280
Bullion produced, oz.	—	45,450
Money value	—	£169,660
Recovery per cubic yard	—	84s. 7d.
Entire Property:		
Cubic yards washed	242,420	287,280
Bullion produced, oz.	129,614	197,327
Money value	£483,850	£736,624
Recovery per cubic yard	39s. 3d.	51s. 3d.



Plan and Elevation of No. 2 Sluice and Bucket Elevator used in Winter Washing, Feodosievsky.

The Big Chanchik mine is noted since the tenor is so high that although the Feodosievsky has decreased in value since 1914-15, the average recovery for all operations has been increased, due to the unusual richness of the Chanchik gravel.

In 1914-15 only the No. 1 sluice was operated at Feodosievsky, washing in the winter season 72,300 cu. yd. with a recovery of 50s. 10d. In addition 2,600 cu. yd. was washed underground in a short sluice, the gravel being so rich that it was considered inadvisable to bring it to the surface. The result of this underground washing was a product of gold to the value of £100,732, or a recovery of £38. 14s. 0d. per cubic yard. The washing of this gravel was conducted in a chamber in the workings specially enlarged for the purpose, and behind doors locked, and specially guarded by police.

In 1915-16 there were two sluices operating at the surface on the Feodosievsky, and the product given above, namely, 137,500 cu. yd. was mainly the result of washing in these units. The extent of underground washing in this season is not known, but probably did not exceed 2000 cu. yd. of the above amount.

Capacity of the Winter Sluices.—As nearly as can be arrived at, the average capacity of the principal winter sluices on the property for the past two years per 18 hour day, two shifts, has been as follows:

	1914-15	1915-16
Feodosievsky.		
No. 1 sluice	425 cu. yd.	405 cu. yd.
No. 2 ,, ...	—	405 cu. yd.
Prokopievsky Sluice:.........	239 cu. yd.	worked out
Andreyevsky Sluice:.........	—	350 cu. yd.
Big Chanchik (Main Sluice)	—	235 cu. yd.

Smaller sluices and *kulibinas* operating on other parts of the property are not given above since their results are comparatively insignificant.

On certain days in the 1915-16 season, the No. 1 sluice Feodosievsky handled 1000 cu. yd. per 18 hour day which is very close to its estimated capacity of 1120 cu. yd. (bank measurement). While the output of no one of the sluices can be said to be satisfactory, there are no technical reasons why the present output should not be steadily increased. Reasons for low output at present are inability to get the feed to the sluices through defects in underground organization, irregular water supply due to excessive falls in temperature on certain days, and various difficulties incidental to starting experimental plants.

Taking the two units of Alaska type sluice which operated during the winter of 1914-15, and comparing them with four units of similar type in corresponding period of 1915-16, the average output per unit per 18 hour day was 343·5 as against 347 cu. yd. as nearly as the figures can be arrived at. For the entire property, counting an average of five sluices and three *kulibinas*, some of which have been operated intermittently, and some only a portion of the time, in 1915-16 an average total daily output of 1690 cu. yd. has been maintained as against 1426 cu. yd. in 1914-15.

Only 164,275 cu. yd. (38% of total mining output for winter) went to the winter dumps in 1915-16, as against 287,335 cu. yd. in 1914-15 (54%). Thus it may be seen that with a continuation of the extension of the winter sluicing methods it would be possible to bring the sluicing output up to the mining output, eliminating the feature of winter dumps almost entirely. At Andreyevsky, and at Innokentievsky, two of the smaller mines, this has, in fact, been done during the present season, while at the Prokopievsky mine in 1914-15 the washing kept pace with the mining during the entire winter. At Feodosievsky 67% of the winter output has been washed in 1915-16 as against 38% in the previous year.

DESCRIPTION OF THE EQUIPMENT AND OPERATION.—It is sufficient to describe the set-up of the No. 2 sluice at Feodosievsky, which was constructed in the autumn of 1915.

Gravel is hoisted through No. 7 Incline Shaft Sofisky in cars by endless rope haulage, the spacing of the cars along the rope being regulated according to the number available coming from the faces. At present the capacity of the sluice is far ahead of the supply, as indicated above. At the head of the incline the car is automatically released, and runs by gravity a distance of 50 ft. to a tipple which automatically dumps it into the elevator boot. The tipple is then righted, and the car runs again by gravity to the incline head on return track. The track is of 23·6 in. gauge laid with 16 lb. rail, and the cars measure inside $30\frac{1}{2}$ by 25 in. at the bottom, are 45 in. long and $22\frac{1}{2}$ in. deep. The displacement level full is 16·4 cu. ft. The cars are not suitable, but owing to adaptation of old material and impossibility of getting new supplies, they are used until larger cars can be secured.

The feed elevator sump or boot is of timber, built up with logs and well banked in with moss. The inside dimensions are 16 by 7 by 8 ft., the rear end sloping so that the bottom has a length of 10 feet.

The bucket ladder is of timber, is of 6 by 6 in. stringers spaced 3 ft. 10 in. centre to centre, and about 45 in. long. It is on an angle of 50° and underlaid by a suitable housing of $1\frac{1}{2}$ in. timber, made to sag conformably to the sag of the bucket line, and with tight sluice bottom so as to return the spill to the elevator boot. The catch-all sluice is made 2 ft. 8 in. wide.

The buckets, of which there are 32 on the line, are of open-connected type and are 4-piece with hood, back, bottom, and lip. They weigh 175 lb. each, and have 2·4 cu. ft. displacement. The main parts are of $\frac{3}{16}$ in. Ural charcoal iron. The lip is 4 by $\frac{5}{8}$ in. manganese steel. The bucket pins are $1\frac{1}{4}$ by $4\frac{1}{4}$ in., the length being measured from under the head. The links are $\frac{5}{8}$ by $3\frac{1}{8}$ in. and in duplicate, the total width of the double strap being $1\frac{5}{16}$ in. The pitch of the buckets and links is the same, 19 in. The bushings are of manganese steel, $\frac{1}{4}$ by $\frac{15}{16}$ in. wide. The rollers have 2 in. shafts and 10 in. cylinders. They sit in chairs on the wooden ladder. Bearings are covered with thin iron hoods.

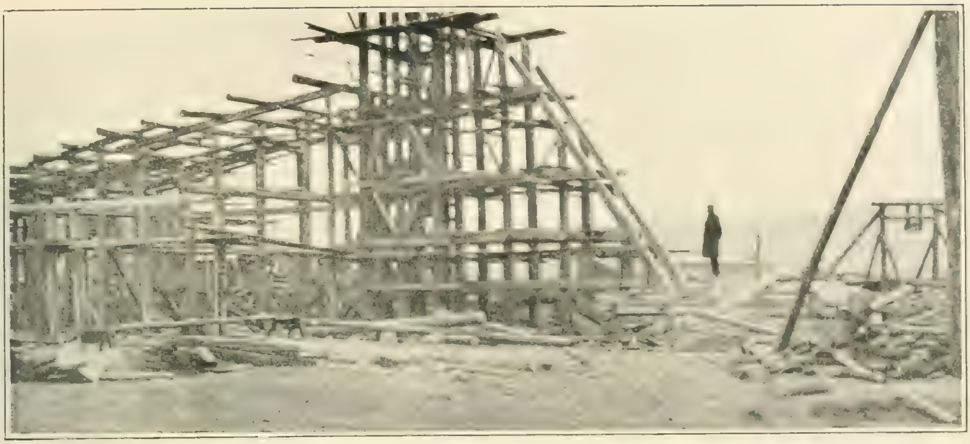
The distance between two tumbler centres is 49·5 ft. on both the feed elevator and the tailing elevator. The horizontal distance between the two tumbler centres is 29·5 feet.

The lower tumbler, without the shaft, weighs 2200 lb. It is hexagonal, with faces conformable to the length of the buckets. The upper tumbler weighs 1150 lb., is four-sided, and has 4 manganese steel blocks 3 in. square by 2 ft. long inset, one in each face to take up the wear caused by the buckets. Manganese steel facings, $\frac{1}{2}$ by 4 in., are fitted to the inside of the faces on both upper and lower tumbler.

Taking the water level in the tailing sump as the datum line, the lift of the gravel in the feed elevator (measured vertically) is 44 ft. and the tailing 36·7 feet. The actual lift of the tailing elevator from the bottom of the boot is also 44 feet.

The main drive sheave on the feed elevator is of wood, locally made, 8 ft. diameter, and geared to the drive wheel of the upper tumbler. That on the tailing elevator is the same, 9 ft. diameter. Belts of gandy, Russian make canvas, 8 in. diameter, are used. The conical gears are 77 in. diameter and weigh 1270 lb. each. The conical pinions are of 19 in. diameter and weigh 150 pounds.

The capacity of each elevator under the above conditions is estimated, running 14 buckets to the minute, at 2016 cu. ft. per hour of loose gravel running 18 hours out of the 24. This is equivalent to 1120 yd. bank measurement. As stated above, the capacity of No. 1 sluice in 1916 very nearly approached this amount during several days.



CONSTRUCTING NO. 2 SLUICE.

INTERIOR OF NO. 1 WINTER SLUICE.

The tailing elevator consists in all its essential details of a duplication of the feed elevator, and merits no other description. The elevator, engine and boiler and attendant parts are strongly housed in log buildings.

Power for driving the elevators is part steam and part electric. A 30 hp. locomobile (portable engine and boiler) is mounted beneath the feed elevator in an adjoining house, and according to experience during 1914-15 it was found that the power to drive a similar elevator and heat the sluice was furnished by 2·63 cords of tamarack wood at 20s. per cord. The heating of the sluice corridor is accomplished by pipes carrying the exhaust steam.

The flywheel of the locomobile is belt-connected to the drive sheave of the upper tumbler as above stated. It was estimated that for the No. 2 sluice the locomobile would be sufficient, steam being conducted to a small horizontal engine at the tailing elevator in addition to the steam used at the head. In practice this did not work out, and an electric motor has been substituted. This should not exceed 12 k.w. for 18 hours at a cost of $1\frac{1}{2}$d. per k.w.h.

Water for the No. 2 sluice is available from a ditch which feeds also a small hydro-electric plant near by. The ditch, which is about 7000 ft. long, supplies in summer time up to 60 second feet of water, but only from 8 to 10 second feet are necessary for the sluice, which quantity is available except in the coldest weather. As a rule it has been found that winter flow available amounts to from 15 to 20% of the summer discharge.

The system of blanketing the ditches with ice in the fall of the year in order that the water may flow uninterruptedly during the winter, originated in Siberia, and has been in practice in the Vitim district for over thirty years. The process is of rather complicated character, and entails considerable expense, but it is effectual and the extra work entailed is soon paid for by results. A special description of the method of freezing over the ditches does not fall within the province of this paper.

As 45 ft. vertical head was available between the pressure box of the ditch and the head box of the sluice, this fact was taken advantage of to utilize about 3 second feet of water through nozzles directed into the head box beside the water directly used in sluicing. This water used through 2 nozzles has had a marked effect in saving gold during the present winter. It was remarked that when the nozzles played into the box, the gold was deposited much nearer the head of the sluice than when they were not used. It is also remarked that when the proportion of the water falls below 16 to 1 volume in relation to gravel, there is a notable loss of gold.

The water conducted through 2 pipes of 10 in. diameter (no 16 in. pipe being available) discharges into the head box, through the sluice, and into the sump or boot of the tailing elevator. Holes punched into the backs of the buckets allow all water from the tailing to also pass into a sump, the tailing being delivered dry to the dump.

From the sump overflow the sludge water from No. 2 flows through a flume on 0·0015 grade a distance of 2800 ft. to the head box of No. 1 sluice farther down the creek. It is planned to shovel out the settlings from this flume during the summer, and re-wash them with quicksilver for fine gold. By this method the same water has been used for the two sluices, a highly desirable economy for winter work.

Construction of the Sluice. — The sluice consists of steel boxes mounted on a frame consisting of 8 in. round poles spaced as shown in the drawing. Caps are 8 in., and on these 8 in. round stringers are laid. On the stringers a bed of cross lagging, 4 in. diameter, set close together, is laid, and loam to the depth of 7 in. spread on the top. On this loam a second set of stringers is laid on which is laid the floor of the sluice corridor. The floor is of 3 in. planks laid crosswise. The corridor is $10\frac{1}{2}$ ft. wide inside measurement, and 7 ft. inside from floor to roof. The walls and roof are of 4 in. poles caulked with moss. Windows are placed at intervals and the whole plant is electrically lighted. The length of the sluice corridor is 280 feet.

The steel sluice-boxes are laid directly on the corridor floor as shown in the section. Boxes are made of one-piece Ural plate steel $\frac{3}{16}$ in. thick, 29 in. wide, 18 in. high, and 8 ft. long. To illustrate some of the difficulties which are encountered in this remote district, it may be mentioned that the steel for these boxes was ordered in June 1914, and reached the property only in August 1915. The steel was bent and punched on the property. Each box weighs 290 lb., and cost for material Rs.36 plus Rs.3 for making. This price includes freight, and works out at Rs.5 or say 10s. per foot at ordinary exchange. For the whole string of boxes £140.

The boxes are slightly tapered so as to fit with 2 in. overlap. The grade of the corridor and sluice is 14 in. to 12 ft., or about 10%. This rather unusually steep grade has been found advisable on account of the angular character of the feed, more than usually obstructive riffles used, and danger of low winter supply of water. Wooden lining boards $1\frac{1}{2}$ by 7 in. are held by lugs to the inside of the boxes to prevent wear and to hold the riffles down.

Riffles are various, according to the character of material being sluiced. The prevalent type up to the present has been the Siberian grate riffle illustrated in the photograph, but some boxes are paved with inverted rails, both longitudinally and transversely disposed. The usual height of the riffles is 3 in. Heavy angle iron riffles have not up to the present been available, but will probably be made use of in the future, since they will serve the same purpose as the grate riffles in breaking up the gravel, and are of less obstructive character. At about the central length of the sluice, a drop-off of about 7 in. is allowed for assistance in breaking the cement of the gravel and increasing the gold saving.

An undercurrent, as illustrated in the drawing, is placed below the sluice and receives the fines which have passed the main riffles. The undercurrent is fed from a longitudinal grizzly of shaped bars, and so regulated by the feeding of additional water, that 40%, being the amount of the fines below 1 in, can pass the bars, which are 56 in. long and from $\frac{3}{4}$ to 1 in. opening.

A cross launder beneath feeds by gates and openings to four steel sluice boxes which act as tables. These are 29 in. wide and 16 ft. long each on 15% grade. All tailing from these as well as from the main sluice runs to the sump.

The success of the undercurrent is not known, but it is planned to give it a good trial and if found of no use to cut it out.

GOLD SAVING.—According to experience in 1914-15, the following savings were made in different portions of the No. 1 sluice, 96% of the total gold content being recovered:

	Per cent.
1st third of the sluice	88·3
2nd " " "	5·5
3rd " " "	2·2
Losses from clean-up box	0·2
Estimated losses from sluice	4·0
	100·0

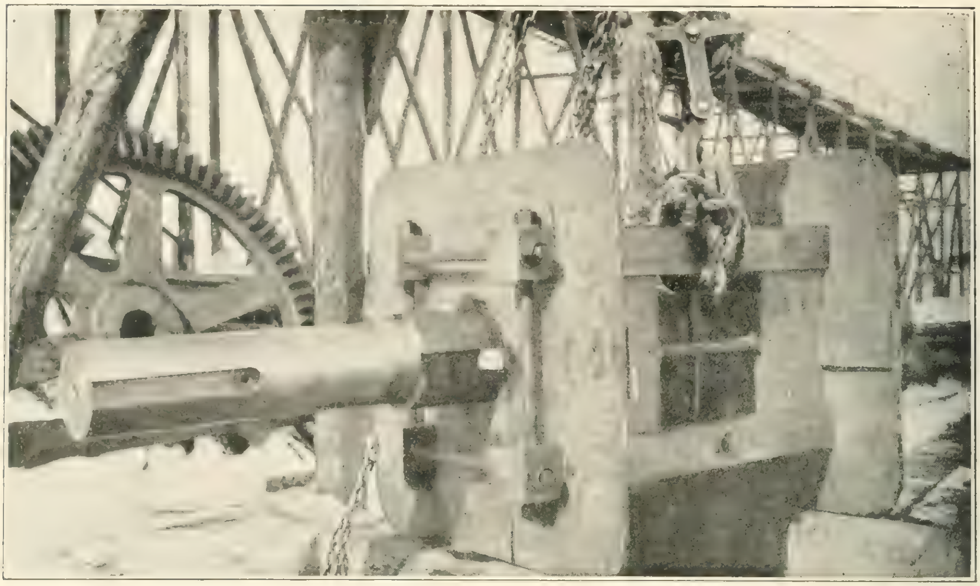
TAILING.—The tailing elevator dumps directly as long as possible. When the gravity dump is filled, the tailing is dumped from the buckets into a hopper, and thence delivered to 1 cu. yd. Koppel cars and trammed by men to form a horse-shoe dump. About 1400 ft. of rails are in use and from 4 to 15 cars, there being 20 men per two shifts on the dump and 2 men on the chute.

REPAIRS.—To judge from the 1914-15 season the amount of repairs has been very moderate. On the No. 1 sluice the only repairs necessary to the elevator after 100,000 cu. yd. had been handled were new bushings for the bucket pins, and the turning of the manganese steel plates in the upper tumbler. It is estimated that the elevators now in use are good for the handling of over 1,000,000 cu. yd. with the lips and parts in use. On the other portions of the plants the repair bill has been nominal.

In general bucket elevators used in gold gravel operations, where the duty of lifting only is required, should be of this light construction so that moves can be easily and quickly made. The gravel elevators formerly used on Bonanza creek in the Klondike, in connection with the creek hydraulicking, were of heavy construction more in the nature of dredge buckets, and in consequence the expense of moving the plant when required was found to be a prohibitive feature.

CLEANING-UP.—This was formerly effected by transferring all the heavy iron pyrite and limonite concentrate in buckets to a table built in the form of a wide long tom. A large amount of unnecessary work was effected. The introduction of the long steel sluice in which the greater part of the gold stops in the first two or three boxes, permits of the rapid sluicing out of the greater portion of the heavy concentrate after riffles are removed, the gold being scooped up directly in the sluice. As it is customary to clean up the head boxes twice a day, at noon and midnight, a great saving of time is effected, and the method is greatly liked by the Russian foremen and clean-up men.

SMALL WINTER SLUICE AT INNOKENTIEVSKY.



UPPER TUMBLER FOR ELEVATOR.

COST OF MATERIAL AND CONSTRUCTION:

Two elevators including the 64 buckets, and one extra tumbler, rollers, chairs, etc., made locally	£700
Steel sluice boxes	140
Riffles and fittings	100
Labour, and materials, lumber, bolts, spikes, piping, nails, moss, earth, etc.	2,500
	£3,440

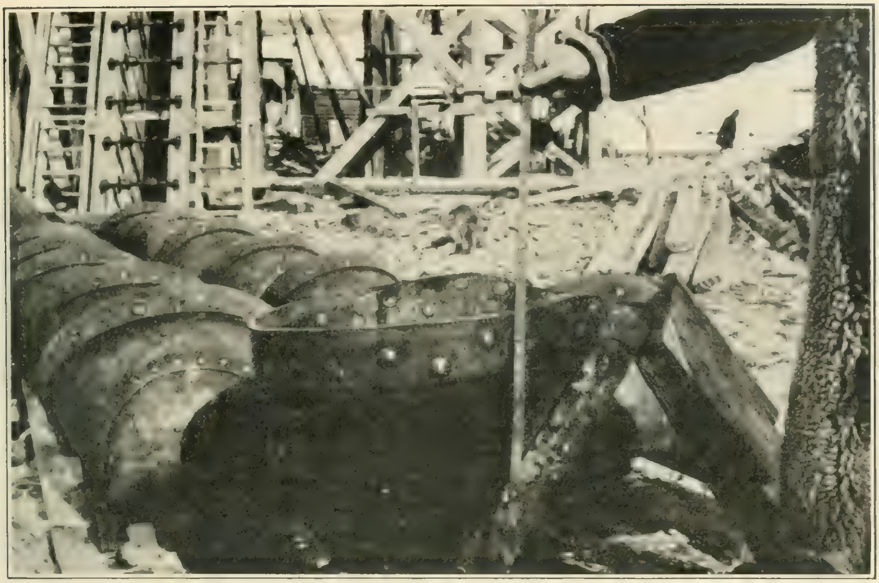
The cost of the steam and electric units used in connection with the plant cannot properly be charged since they are part of permanent plant and their wear and tear are allowed for in depreciation. The labour and materials account to take the plant down and re-erect in another place is estimated at £2,500. For a summer sluice of similar type without the housing the cost would be about 20% less. The erection of the sluices is planned so that the tributary area to be mined will furnish at least three years' work for a given plant before re-erection is necessary.

COST OF WASHING.—On the No. 2 plant which was put in operation only during the past winter, detailed cost is not available, but the following estimate, which agrees closely in total cost with the results of a winter sluice at the Prokopievsky mine during 1914-15, is considered a close approximation. Following this estimate is given the actual cost at Prokopievsky.

COST PER 2 SHIFTS 18 HOUR DAY.

LABOUR:			
On portable engine and boiler:			
2 engineers	at 6s.	12s.	
2 firemen	„ 4s.	8s.	
On motor of tail elevator:			
2 motormen	„ 6s.	12s.	
On general work:			
2 oilers	„ 4s.	8s.	
On sluice:			
10 men	„ 4s.	40s.	
2 nozzlemen	„ 6s.	12s.	
On chute from tail elevator hopper:			
2 men	„ 4s.	8s.	
On dump:			
20 trammers	„ 4s.	80s.	
On plant in general:			
4 foremen	„ 8s	32s.	
Total labour			212s.
POWER:			
5 cords wood for firing portable boiler and heating	at 24s.	120s.	
216 k.w.h. electric power for driving tail elevator	„ $1\frac{1}{2}$d.	27s.	
Lighting, 66 k.w.h.	„ $1\frac{1}{2}$d.	8s.	
Sluicing water, 9 second feet	„ 6s.	54s.	
Incidental and repairs		20s.	
Superintendence and watchmen		80s.	
Depreciation on machinery and materials		60s.	
Total exclusive of labour			369s.
Total working cost			581s.

On the basis of 400 cu. yd. bank measurement washed per working day, the cost was 1s. $5\frac{1}{2}$d. per cu. yd. Comparing this estimate with the actual cost at the Prokopievsky sluice, where water was pumped, and gravel hoisted directly in skips through vertical shaft to head box, and no feed or tailing elevator employed, the detailed cost for March, 1915, was as follows,



2½ CUBIC FOOT BUCKETS FOR ELEVATOR.

on the basis of average output of 330 cu. yd. per day:

Sluicing:		
Water (pumped from shaft, proportion* of pumping expense charged), 4 second feet at £2. 2s. 0d. (Rs. 19 80) per second foot	0·262	
Labour: dumpers, sluice tenders, etc.	0·100	
Materials: mats, nails, riffles	0·003	
Superintendence	0·060	
		0·425
Taking away tailing:		
Labour	0·149	
Stable account	0·030	
Material and breakages	0·021	
Lighting	0·002	
Superintendence	0·032	
		0·234
Repairs and maintenance:		
Labour	0·009	
Materials	0·006	
Watchmen	0·003	
Lighting and power	0·003	
		0·021
Depreciation:		0·036
Total washing cost		Rs. 0·719 (or 1s. 6d. per cu. yd.†)

* Compare difference in cost of gravity water at Feodosievsky sluice with that of pumped water at Prokopievsky.

† The rouble is here taken at pre-war exchange of 9·45 to the pound sterling.

It is difficult to compare the two sluices, as they operate under different conditions. Adding 2d. per cu. yd. to the Prokopievsky cost as the cost of fuel for heating in the colder months previous to March, the total winter cost was 1s. 8d. for a sluice operating under much more difficult conditions and with a less output per day than is the case with the Feodosievsky sluice. Therefore the cost of 1s. 6d. for the No. 2 sluice is probably very nearly correct.

The sluicing plants erected are by no means perfect, and modifications will doubtless be introduced each year depending on experience. There is no reason why the sluicing cost should not be eventually reduced to 1s. per cu. yd. to cover all operations from the time the gravel leaves the shaft collar until the gold and amalgam is delivered to the police to be taken to the melting room. The cost for these operations when the washing output keeps up with the mining output throughout the year should not exceed 10d. per cu. yd., if the improvements already effected are taken advantage of and further developed along similar lines.

An idea of the economy in washing already effected may be had when it is stated that under old methods, washing only in the summer time, the average cost of washing Lenskoi gravel, including the largely unnecessary transport to and from winter dumps and to washing machines from shafts, was 3s. 8d. per cu. yd. The difference of 2s. per cu. yd. credited to over 800,000 cu. yd. average annual output from underground workings adds materially to the profits of the company.

Even this material saving appears small, however, when compared with the additional benefits which accrue from the higher recovery due to lessening the theft, improved saving, and the ability to make bullion shipments regularly throughout the year instead of having half the output tied up in winter dumps for six months of the year.

CONVERSION TABLES FOR THE VALUATION OF ORES, MINERALS, AND METALS

Tables for converting cents or pence per pound into £ sterling per ton and for similarly calculating values at cents or pence per unit at various percentages of the constituent paid for.

IT is one of the unfortunate conditions faced by those concerned with the international trade in metals, that the standards of weights and measures as well as the monetary systems in various countries are not the same. They are not even the same for all products in the same country, as witness the United States, where, while the term ton almost always means 2000 lb., iron ore, anthracite coal, and several other mineral products are measured in 'long' tons of 2240 lb. In South Africa the 'short' or 2000 lb. ton is in general but not universal use. In French, Spanish and Italian-speaking countries the metric ton, 2204·6 lb., is almost always the legal standard, but trade is in fact conducted in all sorts of local measures, especially in the colonies. It is worth remembering that in more than one country a contract, to be strictly legal, must be in terms of the metric system even though in fact trade be in *cargas* or some such similar measure relating back to what a man or a mule can conveniently carry. Conversion factors are easily calculated or are readily available in standard text books or any good engineer's pocket book. To convert metric tons into English or 'long' tons, for example, it is only necessary to multiply by 1·016. To make the change to the colonial or American 'short' ton multiply instead by 0·9842. To make many such computations, however, is wearisome and time-wasting, all the more so if dollars and cents must at the same time be changed to pounds, shillings, and pence. This is the problem that is faced every day when one reads that copper is selling in New York at 27c. per lb., and wants to know what that means in pounds sterling per ton. There is an excellent little table of English and American price equivalents in a little handbook called 'Metal Statistics' published by the American Metal Market. As it is not generally available we reproduce below a brief table calculated by Mr. David Ladd, on the basis of normal exchange, the £ being worth $4·8665, and at $4·80, a figure that has been common since the war opened. It will be noticed that differences in exchange alter the ratios materially, and as exchange varies from day to day the simple system is to first find the quotation at normal exchange and then reduce it to that of the day by multiplying by the decimal representing the ratio of current exchange to normal. Thus a quotation of 10c. per lb. in New York would be equivalent to £46·03 per long ton in London. When exchange is at $4·76, as recently, the American dollar is worth 1·021 times its normal value. Therefore the 10c. quotation becomes equivalent to $1·021 \times 46·03 = 46·99$ or, nearly, 10c. New York means £47 London. This is a convenient figure to carry in the head just now, since from it any other New York quotation can be deduced by the one operation, lead at $6\frac{1}{2}$ cents being 0·65 that amount, or £30·55. Such figures, and indeed conversion tables generally, do not of course take into account the actual cost of transfer of metal, including freight, insurance, brokerage, etc. They are only useful as a means of learning how much these items come to, and of correlating other information. Mr. Ladd's table, followed by more elaborate ones prepared and used for several years by Mr. George T. Holloway, and suitable for more exact work, follow.

TABLE I.—*Illustrating effect on exchange.*

Cents per lb.	£ per ton at 4·866	£ per ton at 4·80	Cents per lb.	£ per ton at 4·866	£ per ton at 4·80
1	4·603	$4\frac{2}{3}$	11	50·63	$51\frac{1}{3}$
2	9·210	$9\frac{1}{3}$	12	55·24	56
3	13·81	14	13	59·84	$60\frac{2}{3}$
4	18·41	$18\frac{2}{3}$	14	64·44	$65\frac{1}{3}$
5	23·01	$23\frac{1}{3}$	15	69·04	70
6	27·62	28	16	73·65	$74\frac{2}{3}$
7	32·22	$32\frac{2}{3}$	17	78·25	$79\frac{1}{3}$
8	36·82	$37\frac{1}{3}$	18	82·85	84
9	41·43	42	19	87·46	$88\frac{2}{3}$
10	46·03	$46\frac{2}{3}$	20	92·06	$93\frac{1}{3}$

Mr. Holloway's tables follow.

They have been worked out with a mechanical calculator from the factors normally employed by the United States Treasury Department and in Great Britain, for converting sterling values into dollars and cents, and are approximately correct to five significant figures, although it is commonly sufficient to use only the first three. The following factors have been used:

Cents	Dollars	Pence	Shillings	Pounds
1	0·01	0·49317	0·041097	0·0020549
100	1	49·317	4·1097	0·20549
2·0277	0·020277	1	0·083333	0·0041667
24·333	0·24333	12	1	0·05
486·67	4·8667	240	20	1

TABLE II.—*For converting cents or pence per pound into £ sterling per ton.*

1 cent equals 0·49317 pence | 1 cent equals 0·0020549 £ sterling
1 penny „ 2·0277 cents | £1 sterling „ 486·67 cents or 4·8667 dollars

To convert cents per pound into dollars per ton of 2000 lb. multiply by 20.

Per pound		Per ton of	
Cents	Pence	2000 lb. £	2240 lb. £
0·21725	0·10714	0·82986	1
0·24333	0·12000	1	1·1200
¼	0·12329	1·0274	1·1507
0·43450	0·21428	1·7857	2
0·48667	0·24000	2	2·2400
½	0·24658	2·0549	2·3014
0·50692	¼	2·0833	2·3333
0·65175	0·32142	2·6786	3
0·73000	0·36000	3	3·3600
¾	0·36987	3·0824	3·4521
0·86900	0·42857	3·5714	4
0·97334	0·48000	4	4·4800
1	0·49317	4·1098	4·6029
1·0138	½	4·1667	4·6667
1·0862	0·53570	4·4643	5
1·2167	0·60000	5	5·6000
1·3035	0·64286	5·3571	6
1·4600	0·72000	6	6·7200
1·5202	¾	6·2500	7
1·7034	0·84000	7	7·8400
1·7380	0·85712	7·1428	8
1·9467	0·96000	8	8·9600
1·9553	0·96428	8·0357	9
2	0·98634	8·2196	9·2058
2·0277	1	8·3333	9·3333
2·1725	1·0714	8·9286	10
2·1900	1·0800	9	10·980
2·4334	1·2000	10	11·200
3	1·4795	12·329	13·808
4	1·9727	16·439	18·412
4·0554	2	16·667	18·667
4·3450	2·1428	17·857	20
4·8667	2·4000	20	22·400
5	2·4658	20·549	23·014
6	2·9590	24·659	27·617
6·0835	3	25	28
6·5175	3·2143	25·786	30
7	3·4522	28·769	32·220
7·3000	3·6000	30	33·600
8	3·9454	32·878	36·823
8·1108	4	33·333	37·333
8·6900	4·2857	35·714	40
9	4·4385	36·988	41·426
9·7336	4·8000	40	44·800
10	4·9317	41·098	46·039
10·138	5	41·667	46·667
10·862	5·5370	44·643	50
12·167	6	50	56
13·035	6·4284	53·572	60
14·194	7	58·333	65·333
14·600	7·2000	60	67·200
15·208	7·4998	62·500	70
16·222	8	66·667	74·667
17·034	8·4000	70	78·400

Per pound		Per ton of	
Cents	Pence	2000 lb. £	2240 lb. £
17·380	8·5712	71·429	80
18·249	9	75	84
19·467	9·6000	80	89·600
19·552	9·6426	80·357	90
20	9·8634	88·196	92·058
20·277	10	83·333	93·333
21·725	10·714	89·286	100
21·900	10·800	90	100·80
22·305	11	91·667	102·67
Dollars	**Shillings**		
0·24334	1	100	112
0·3	1·2329	123·29	138·08
0·4	1·6439	164·39	184·12
0·43450	1·7857	178·57	200
0·48668	2	200	224
0·5	2·0549	205·49	230·14
0·6	2·4658	246·58	276·17
0·65175	2·6786	267·86	300
0·7	2·8768	287·68	322·20
0·73000	3	300	336
0·8	3·2878	328·78	368·23
0·86907	3·5715	357·15	400
0·9	3·6987	369·87	414·25
0·97336	4	400	448
1	4·1098	410·98	460·29
1·0862	4·4643	446·43	500
1·2167	5	500	560
1·3035	5·3572	535·72	600
1·4600	6	600	672
1·5208	6·2500	625	700
1·7034	7	700	784
1·7380	7·1429	714·29	800
1·9467	8	800	896
1·9552	8·0357	803·57	900
2	8·2196	821·96	920·57
2·1725	8·9286	892·86	1000
2·1900	9	900	1008
2·4334	10	1000	1120
2·6767	11	1100	1232
2·9200	12	1200	1344
3	12·329	1232·9	1380·9
3·1634	13	1300	1456
3·2589	13·393	1339·3	1500
3·4068	14	1400	1568
3·6500	15	1500	1680
3·8934	16	1600	1792
4	16·439	1643·9	1841·1
4·1368	17	1700	1904
4·3450	17·857	1785·7	2000
4·3800	18	1800	2016
4·6234	19	1900	2128
4·8667	20	2000	2240
5	20·549	2054·9	2301·4

TABLE III. *For converting values in pence or cents per 'unit,' or vice versa, to price in £ sterling per ton, at various percentages.*

(Multiplying the figure under 10% by 10 will give the value of mineral at 100% purity and dividing by 10, at 1% purity. Thus 10c. per unit for ore containing 21·1% metal may be found by adding 0·41098 plus 0·020549, plus 0·0020549. The values per ton are the same for both the long ton, 2240 lb. and the short ton, 2000 lb., because the 'unit' is 20 lb. for the former and 22·4 lb. for the latter).

Quotations on ores and minerals must necessarily take account of the amount of valuable metal in the material sold. Clearly an ore containing 10% of lead is worth less than one containing 20%. It is customary, therefore, to specify a certain standard of purity, or percentage of metal and to increase or decrease the price according to the purity of the ore above or below that standard. These standards vary with the material and in part with the locality. Thus Indian manganese ore is quoted on a "50% basis," which means that each ton delivered must contain 50% metallic manganese, or to use the trade term 50 'units,' subject to agreed or customary penalties and premiums for variation below or above. Wolfram ores are sold on a basis of 70 'units' or 70% content of WO_3. In America, Joplin zinc ores, being very pure, are quoted on a 60% basis, meaning a content of 60% or 60 units of metallic zinc, the short ton being standard. Colorado ores, and mixed zinc ores in general, are sold on a 40% or 40 unit basis. To convert American into British prices, the following table, used by Mr. Holloway, will be found most convenient.

Price per 'unit' (*i.e.* for each 1%).		Price per ton of material at various percentages of constituent paid for.								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
Pence	Cents	£	£	£	£	£	£	£	£	£
0·12329	¼	0·0051372	0·010274	0·015412	0·020549	0·025686	0·030823	0·035960	0·041098	0·046235
⅛	0·25346	0·0052083	0·010667	0·015625	0·020833	0·026042	0·031251	0·036458	0·041667	0·046375
0·24658	½	0·010274	0·020549	0·030822	0·041098	0·051371	0·061646	0·071920	0·082196	0·092467
¼	0·50692	0·010417	0·020833	0·031251	0·041667	0·052085	0·062500	0·072919	0·083333	0·093753
0·36987	¾	0·015412	0·030822	0·046236	0·061646	0·077055	0·092467	0·10788	0·12329	0·13870
0·49317	1	0·020549	0·041098	0·061646	0·082196	0·10274	0·12329	0·14384	0·16439	0·18494
½	1·0138	0·020833	0·041667	0·062500	0·083333	0·10417	0·12500	0·14584	0·16667	0·18751
¾	1·5208	0·031251	0·062500	0·093753	0·12500	0·15625	0·18751	0·21876	0·25000	0·28126
0·98634	2	0·0410918	0·082196	0·12329	0·16439	0·20549	0·24659	0·28768	0·32878	0·36988
1	2·0277	0·041667	0·083333	0·12500	0·16667	0·20833	0·25000	0·29167	0·33333	0·37500
1·4795	3	0·061646	0·12329	0·18494	0·24659	0·30822	0·36988	0·43152	0·49317	0·55481
1·9727	4	0·082196	0·16439	0·24659	0·32878	0·41098	0·49317	0·57537	0·65756	0·73975
2	4·0554	0·083333	0·16667	0·25000	0·33333	0·41667	0·50000	0·58334	0·66667	0·75000
2·4658	5	0·10274	0·20549	0·30822	0·41098	0·51371	0·61646	0·71920	0·82196	0·92467
2·9590	6	0·12329	0·24659	0·36988	0·49317	0·61646	0·73975	0·86304	0·98635	1·1096
3	6·0831	0·12500	0·25000	0·37500	0·50000	0·62500	0·75000	0·87500	1	1·1250
3·4522	7	0·14384	0·28768	0·43152	0·57537	0·71920	0·86304	1·0069	1·1507	1·2946
3·9454	8	0·16439	0·32878	0·49317	0·65756	0·82196	0·98635	1·1507	1·3151	1·4795
4	8·1108	0·16667	0·33333	0·50000	0·66667	0·83333	1	1·1667	1·3333	1·5000
4·4385	9	0·18494	0·36988	0·55481	0·73975	0·92467	1·1096	1·2946	1·4795	1·6644
4·9317	10	0·20549	0·41098	0·61646	0·82196	1·0274	1·2329	1·4384	1·6439	1·8494
5	10·138	0·20833	0·41667	0·62500	0·83333	1·0417	1·2500	1·4584	1·6667	1·8751
6	12·166	0·25000	0·50000	0·75000	1	1·2500	1·5000	1·7500	2	2·2500
7	14·194	0·29167	0·58334	0·87501	1·1667	1·4584	1·7500	2·0417	2·3333	2·6250

TABLE III—*continued.*

Price per 'unit' (*i.e*, for each 1%).		Price per ton of material at various percentages of constituent paid for.								
		10%	20%	30%	40%	50%	60%	70%	80%	90%
Pence	Cents	£	£	£	£	£	£	£	£	£
8	16·222	0·33333	0·66667	1	1·3333	1·6667	2	2·3333	2·6667	3
9	18·249	0·37500	0·75001	1·1250	1·5000	1·8750	2·2500	2·6250	3	3·3750
9·8634	20	0·41098	0·82196	1·2329	1·6439	2·0549	2·4659	2·8768	3·2878	3·6988
10	20·277	0·41667	0·83333	1·2500	1·6667	2·0833	2·5000	2·9167	3·3333	3·7500
11	22·305	0·45834	0·91668	1·3750	1·8334	2·2917	2·7500	3·2084	3·6667	4·1251
Shillings	**Dollars**									
1	0·24333	0·50000	1	1·5000	2	2·5000	3	3·5000	4	4·5000
1·2329	0·3	0·61646	1·2329	1·8494	2·4659	3·0822	3·6988	4·3152	4·9317	5·5481
1·6439	0·4	0·82196	1·6439	2·4659	3·2878	4·1098	4·9317	5·7537	6·5756	7·3975
2	0·48667	1	2	3	4	5	6	7	8	9
2·0549	0·5	1·0274	2·0549	3·0822	4·1098	5·1371	6·1646	7·1920	8·2196	9·2467
2·4658	0·6	1·2329	2·4659	3·6988	4·9317	6·1646	7·3975	8·6304	9·8635	11·096
2·8768	0·7	1·4384	2·8768	4·3152	5·7537	7·1920	8·6304	10·069	11·507	12·946
3	0·73000	1·5000	3	4·5000	6	7·5000	9	10·500	12	13·500
3·2878	0·8	1·8439	3·2878	4·9317	6·5756	8·2196	9·8635	11·507	13·151	14·795
3·6988	0·9	1·8494	3·6988	5·5481	7·3975	9·2467	11·096	12·946	14·795	16·644
4	0·97334	2	4	6	8	10	12	14	16	18
4·1098	1	2·0549	4·1098	6·1646	8·2196	10·274	12·329	14·384	16·439	18·494
5	1·2167	2·5000	5	7·5000	10	12·500	15	17·500	20	22·500
6	1·4600	3	6	9	12	15	18	21	24	27
7	1·7034	3·5000	7	10·500	14	17·500	21	24·500	28	31·500
8	1·9467	4	8	12	16	20	24	28	32	36
8·2196	2	4·1098	8·2196	12·329	16·439	20·549	24·659	28·768	32·878	36·988
9	2·1900	4·5000	9	13·500	18	22·500	27	31·500	36	40·500
10	2·4334	5	10	15	20	25	30	35	40	45
11	2·6767	5·5000	11	16·500	22	27·500	33	38·500	44	49·500
12	2·9200	6	12	18	24	30	36	42	48	54
12·329	3	6·1646	12·329	18·494	24·659	30·823	36·988	43·152	49·317	55·481
13	3·1633	6·5000	13	19·500	26	32·500	39	45·500	52	58·500
14	3·4067	7	14	21	28	35	42	49	56	63
15	3·6500	7·5000	15	22·500	30	37·500	45	52·500	60	67·500
16	3·8933	8	16	24	32	40	48	56	64	72
16·439	4	8·2196	16·439	24·659	32·878	41·098	49·317	57·536	65·756	73·976
17	4·41366	8·5000	17	25·500	34	42·500	51	59·500	68	76·500
18	4·3800	9	18	27	36	45	52	63	72	81
19	4·6233	9·5000	19	28·500	38	47·500	57	66·500	76	85·500
20	4·8667	10	20	30	40	50	60	70	80	90
20·549	5	10·274	20·549	30·823	41·098	51·372	61·646	71·922	82·196	92·471

DISCUSSION

Nigerian Tin Deposits.

The Editor:

Sir — I have read Mr. Rumbold's letter in reference to my article on the tin deposits of Northern Nigeria with considerable interest.

I would, however, point out that in the matter of the occurrence of quartz he has selected remarks on an individual deposit and taken them as applying to the field as a whole. Other portions of the paper clearly indicate that I had no intention of dissociating the intimate occurrence of quartz and cassiterite.

As regards reconcentration from older deposits, the views held by Mr. Rumbold may be identical with those of the authority he quotes, but as in the preface to 'The Geology and Geography of Northern Nigeria' it is made clear that the opinions expressed are purely tentative and a groundwork only for subsequent investigation, it would be as well to await the completion of Dr. Falconer's observations before accepting his conclusions as final. Possibly, as in the instance of the Federated Malay States, where after several years research opinions as to the origin of the tin-bearing deposits of that country are still at variance, it will be some years before any generally accepted theory will be arrived at.

London, July 31. H. E. NICHOLLS.

Chuquicamata and Far East Rand.

The Editor:

Sir—In your very interesting article bearing upon 'American Capital and the Rand' you refer to the Chuquicamata mines in Chile and speak as to the "unsolved metallurgical problems." The *Engineering and Mining Journal* of New York (Feb. 17), gives an article by E. A. Rose entitled 'Metallurgical operations at the Chile Exploration Company' in which he is made to say as follows: "Although the operations of the Chuquicamata plant have not yet been brought up to the full capacity of 10,000 tons per day, this is not on account of any basic defect in the process, but rather due to the unusual troubles encountered in starting any new metallurgical plant."

If I am not asking too much of you would you mind informing me as to the difficulties yet to be surmounted before this great undertaking spells success?

Kingswear, July 24. G. H. COLLINS.

[Our reference was to the metallurgical problems that were unsolved at the time the Chuquicamata mines were taken up. The fact that a working process had still to be developed constituted a risk that does not enter in the case of a new venture on the Far East Rand. In the latter field standard methods of treatment have already been formulated and tested by actual operations on a large scale, and so far as treatment is concerned opening a new mine is like adding another unit to an existing plant. As to the success at Chuquicamata, there is little that can be added to the excellent statement made by Mr. Rose. Substitution of duriron for magnetite anodes, made necessary by war conditions, has increased the current consumption, but there are advantages that partly compensate for this. Other difficulties, such as the heating of the solutions, are being overcome, and on the whole the new plant seems to be settling down to routine in surprisingly quick time and with a minimum of difficulties.—EDITOR.]

Origin of Chilean Nitrates.

The Editor:

Sir—In the July number of *The Mining Magazine* I notice the following statement in the review of the paper by Dr. Singewald and myself: "Here we would interpolate the remark that the older theories were published at a date earlier than the discovery of the great deposits of Chile, and had reference to deposits in southern Peru." In a way the statement is correct yet it is based on a misconception. The explanation is that the region where now, as in the past, the greatest exploitation of the nitrate deposits has been done is in the provinces taken from Peru and Bolivia by Chile at the close of the war between those countries and the older theories, as well as more recent ones, have been based on studies in the same nitrate fields. The nitrate fields remaining in the possession of Peru are of little consequence.

BENJ. L. MILLER.

South Bethlehem, Pa., August 18.

[Mr. Miller is correct and the point is worth noting. What we had in mind was the fact that anyone reviewing the early literature would need to turn to Peru rather than Chile for sources.—EDITOR.]

SPECIAL CORRESPONDENCE

CAMBORNE.

The many difficulties under which Cornish mining operations are being carried on at the present time are well illustrated in the recently issued half-yearly reports of some of the leading mines. Dearth of underground labour, high prices for materials, heavy taxation, and the comparatively low price ruling for tin, which is the principal product, are all having their effect, and it speaks well for the management of the mines that most of them are able to make ends meet.

DOLCOATH showed a profit of £6883 for the six months, but from this must be deducted £2507 for depreciation of buildings and plant. This compares with a loss, including depreciation, for the previous half-year of £7487, so that a really substantial improvement has been shown. The tonnage handled was 41,384 tons, and the sales of tin concentrate amounted to 577 tons, or a yield of 31·2 lb. per ton. This concentrate realized an average price of £108 per ton. The total receipts averaged 30s. 5·5d., and the working costs (including royalties 2s.) 27s. 1·5d. per ton, this latter being higher by 2s. 10d. per ton as compared with the pre-war working cost. The development footage dropped to 495 ft., as compared with 882 ft. the previous half-year, but this fall is doubtless due to the labour difficulty, for it is admitted that the mine is not being properly developed. The arrangement foreshadowed at the last shareholders' meeting of a substantial remission of dues by the new lords has not materialized, or at any rate not in the form expected by the directors. The lords offered to advance £4000 to be expended on certain development work, but it was stipulated that the amount should be repaid out of the profits (if any) made as a result of this special scheme of development. Of course, a complete remission of dues at such a time would have been encouraging to the shareholders, but still the offer shows that the new lords were willing to take their share in the ordinary mining risk of developing the western ground, and to lose their money if it did not make good. This is a distinct advance on the attitude of the average Cornish land-owner, and deserves recognition as such, even although the directors of Dolcoath did not deem help necessary on such terms.

The development ends at the 490 and 440 fathom levels west of Harriett shaft have not yet opened up any payable tin ground, but the 490 end seems to be particularly promising. The character of the lode is much the same as where a richer mineral content is in evidence, and Captain Arthur Thomas is evidently hopeful of an early improvement. The two cross-cuts north from Stray Park shaft are important development points. The one at the 238 fathom level has been driven 63 fathoms and should shortly intersect the Harriett series of north lodes, which have not been seen yet in this section of the mine, but which were profitably worked in Wheal Harriet 15 years ago. From the speech of the manager, it would appear that the main lode at the 550 fathom level (the bottom of the mine) is proving to be much wider and more productive than previous developments had led him to believe.

THE GRENVILLE report and accounts do not make very cheerful reading, the loss for the six months ended June 30 last being £3566. During this period 21,594 tons of ore was treated, producing 265 tons of tin concentrate, an extraction of 27·47 lb. per ton milled. The tonnage handled is lower by 1500 tons, and the extraction by 1·33 lb. per ton. The directors express the view that "it had been hoped that developments would lead to improvement in values, having regard to the energetic measures adopted in exploratory work." But the development footage was only 656 ft. (or 1 foot for every 33 tons milled), and in the previous half-year only 853 ft., and no mining man could call such a ratio reasonably energetic. The Grenville management has been too timorous in its development programme for the past few years, years in which large profits were made and when vigorous development could have been undertaken without financial strain. The payable ground in Grenville occurs in shoots, and development well ahead is essential if average returns are to be maintained. The loss of miners is not so serious at this as at other mines; indeed, few tin mines in the county have lost so small a proportion of their underground forces, about 20%. The mine, in the opinion of local people with mining knowledge, would well respond to vigorous development, and it is to be hoped that this policy will be adopted while the financial position of the company admits of its being done. The management of the company in other respects is all that can be desired. The shoots of tin in the 395 and 375 fathom levels have been neither large nor very productive, but farther west richer ground may be found.

AT CARN BREA AND TINCROFT, a profit has been earned for the half-year ended June 30 of £3691, or, less £681 depreciation written off, a net sum of £3010, and we have to go back to 1912 for such a satisfactory statement. The quantity of ore treated was 28,586 tons, or roughly 1200 tons less than the previous six months, while 271 tons of tin concentrate was produced, showing an average extraction of 21·22 lb. per ton, exclusive of wolfram and arsenic. No figures of yield are given respecting these by-products, but they realized a sum of £10,363 (wolfram £3792, arsenic £6571). The total receipts per ton of ore treated figure at 28s. 3d. per ton and the working cost (including royalties 11d. per ton) at 25s. 8d., the profit (excluding depreciation) being 2s. 1d. per ton. The development was 1122 ft., or one foot for every 26 tons milled. There has been practically no reduction in the labour force at this mine since the introduction of compulsory military service, because all mines producing wolfram are on the Government reserved occupation list. North Tincroft appears to be opening up fairly well, and the average recovery should be at any rate maintained for the current six months. Proposals are shortly to be submitted for a reduction in the capital of the company, which now stands at £135,553. As the £1 fully paid priority shares can be purchased at 7s. 6d. per share, and as the Carn Brea section of the property has been abandoned, the wisdom for this proposed reduction will be readily appreciated.

LEVANT.—Although the accounts of the Levant mine are issued every four months, there must be very few outsiders who could forecast ahead whether the next account would show a profit or a loss. The statement for the four months ended April 8, 1916, showed a profit of £2003; that for the period ended July 29 last, a loss of £236. It is true that, owing to a breakage in the shaft, the ore milled had been lessened by 1000 tons, without which there would certainly have been a profit. But the loose system of accountancy in vogue at this mine makes it quite out of the question to secure reliable cost figures or accurate statements of account each four months; but as I dilated on this question in the June issue, there is no need for further comment here. The tonnage milled was 7309, the tin concentrate produced 143 tons, and the average extraction 43 lb. per ton. Unstated quantities of copper and arsenic were also produced. Mr. J. C. Tregarthen gave some interesting figures respecting increased cost of materials. For instance, they were paying 5s. per cubic foot for pitch-pine as against 1s. 11d.; for iron rails £16 per ton as against £6. 10s. 0d.; for wire rope 41s. per cwt. against 28s.; for coal 30s. per ton against 17s.; and so on in many other classes of stores. In June 1914, 155 men and 20 boys were employed on tutwork and tribute; in August 1915 the number similarly engaged was 152 and 13, so that if the number of the company's miners serving with the Forces is as large as the speeches at the meeting indicated, then they must have been replaced by others.

THE CORNISH CHAMBER OF MINES does not seem to make such rapid progress as well-wishers would like to see, and one wonders why. Although excess profits tax is not likely to trouble more than one or two mines, which could be readily named, yet the need for the Cornish mining industry to make representations to the Board of Referees for a more equitable interest percentage is highly desirable. Base metal mines are likely to have a much more difficult task than gold mines in securing favourable consideration, but Cornish mining is a national industry, and needs special treatment.

Another matter the Chamber should tackle promptly is the provision of mining scholarships; the example given by the Weardale Lead Co. and referred to elsewhere in this issue, should encourage some of the wealthier Cornish mining companies to provide funds for this purpose, the Chamber of Mines for preference to arrange the details.

WHEAL KITTY. — Work at the Wheal Kitty & Penhalls mines, situated at St. Agnes, and in which the late J. H. Collins was so prominently interested, has been largely suspended, and owing to the weakness of the company's financial position, a receiver and manager has been appointed by the Court on behalf of the debenture holders. This company was seriously damaged by the unduly large proportion of its underground force having been called-up for military service, and seeing that every encouragement had successfully been given to volunteers in the earlier days of the war, the authorities should have protected the company against the compulsory service of those remaining. However, the damage was done before the mining court, referred to in the July issue, was established, and this, coupled with poor developments, and a lack of capital to sink Sara's shaft and for further development work, made it necessary to curtail operations pending the provision of further capital. The mine is now being worked on tribute. If more tributers were available, it could probably be made to pay its way. Negotiations are stated to be on foot for an amalgamation of Wheal Kitty and West Kitty mines, and it is rumoured that working capital to the amount of £30,000 will be available if the scheme matures. There can be no question that the amalgamation of these two properties is the right policy. They could readily be connected; one pumping plant could drain the two mines; the ore from both mines could be drawn through Sara shaft, which is an excellent five-compartment shaft ; while the new Wheal Kitty mill, if enlarged, would treat the output of both mines. The Jericho mill, owned by West Kitty (about a mile and a half away from the mine) could then be dismantled. The advantages of amalgamation are apparent to anyone who knows the district ; the surprise is that nothing has been done before in the direction of bringing it about.

TORONTO.

PORCUPINE.—The official statement of the Dome Mines for July shows a total production of $181,000, from the treatment of 88,150 tons of ore of the average value of $4·74 per ton. Working costs were $2·61 per ton. The orebody on the 700 ft. level has been developed for a width of over 240 ft. by 40 ft. in length, the ore averaging $5 per ton. The Hollinger Consolidated, during the period of 4 weeks ended July 14, treated 45,320 tons of ore of the average value of $9·15 per ton, realizing gross profits of $215,165. The working costs were $3·74 per ton milled. The returns were not equal to the dividend requirements under the new capitalization, the deficit being $202,934. It is expected that this will be speedily made up, as the delays in the construction of the new mill have been overcome. The additional ball-mill has since commenced operations, bringing the daily capacity of the plant up to 1900 tons. In sinking a new shaft on the Millerton property of the company a narrow but rich vein showing visible gold has been found. The Schumacher will sink a new 4-compartment shaft to a depth of 500 ft., which will be connected with shaft No. 1. A new vein has been found in a cross-cut on the 100 ft. level, 2 ft. in width, with a good showing of free gold. At the Davidson, a new vein 8 ft. wide has been found on the surface. The shaft is being sunk from its present depth of 265 ft., and stringers cut in sinking are believed to indicate the occurrence of another orebody. The shaft at the Dome Lake is down 400 ft., and sinking will be continued to the 700 ft. level. The 300 and 400 ft. levels are opening up well. A 200 ton mill will be installed. At the Newray, formerly the Rea mine, a promising 40 ft. quartz vein has been found on the surface and traced for some distance. It is stated to assay $4 per ton across its entire width. Diamond drilling at the Dome Extension has shown good ore at the depth of about 1000 ft., the width of the vein being estimated at 40 ft. The new vein found on the McIntyre at the 1000 ft. level along the line of the McIntyre Extension has been driven 500 ft., and varies in width from 8 to 40 ft.

KIRKLAND LAKE.—Development on most of the properties in this district is being suspended until electric power can be obtained from the Northern Ontario Light & Power Co.'s plant at Cobalt, which is not expected before November. The Tough Oakes during July was an active producer, the output being about $88,000. A new ore-shoot 120 ft. long of good average grade has been developed on the 200 ft. level. A large compressor and other new equipment has been ordered for the Lake Shore mine, operations on which will be resumed as soon as power is available. The Wright-Hargraves is erecting buildings and preparing to instal equipment.

COBALT. — The silver-mining industry is showing much activity. Seventeen more companies are operating in the Cobalt district than last year. The Nipissing during July produced ore to the estimated value of $288,577, and shipped bullion from Nipissing and customs ore to the estimated value of $280,188. The cost of production is estimated at about 18½c. per oz. The La Rose has discontinued work in the tunnel under the bluff on the La Rose Extension property, started last winter for exploration purposes, as the results were not encouraging. Operations are continued in the old workings. The Beaver, having reached the lower contact between the diabase and Keewatin formations, has cut a station at 1600 ft. and started three cross-cuts. The Timiskaming shaft is down 1240 ft. and will start cross-cutting when a lowel level has been reached. The exploration at depth by these companies is being watched with great interest, as their success would mean a prolongation of the life of the district. A 2 in. vein containing native silver has been found on the Hudson Bay property. At the Adanac the vein previously developed on the 280 ft. level has been found on the 330 ft. level, where it is about 3 in. wide, of high-grade ore. A shipment will shortly be made. The Little Nipissing leasehold property has been taken over from the Peterson Lake by a Toronto-Detroit syndicate. J. W. Wilson, formerly connected with the Associated Gold Mines of Western Australia, has been placed in charge. The Lorrain Consolidated, in the South Lorrain district, is sinking its shaft from the present depth of 110 ft. to the 400 ft. level. The Belle Ellen, another South Lorrain property, is being operated by a syndicate which will undertake deeper mining. Other properties in this district are also being worked.

BUSH FIRES.—During the last days of July large areas of Northern Ontario were devastated by forest fires, which destroyed several towns and villages and caused the loss of about 250 lives. The sufferers were principally settlers, many of whose homesteads were burned. The mining districts generally escaped, though Porcupine was for some time in danger. The principal loss in the mining areas was at the Crœsus mine in Munro Township, the surface plant of which was burned, several of the miners losing their lives. A number of prospectors in this neighbourhood were burned to death. The clearing of forest vegetation from large areas laying bare the rock is expected to result in important mineral discoveries, as was the case after the Porcupine fire in 1911.

THE NICKEL QUESTION.—The agitation for the absolute prohibition of all exports of nickel ore and its refining in Canada has assumed a new phase. The question has been taken up by the Liberals as a political issue, and the results of a by-election held in Toronto indicate that the sentiment aroused may seriously endanger the position of the government. In the contest just closed for the representation of one of the Toronto divisions in the Provincial Legislature, the Liberal candidate strongly assailed the policy of the Canadian and Ontario governments, charging them with aiding the Germans against the Allies by permitting Canadian nickel to be refined in the United States. The constituency is normally strongly Conservative, the majority for that party at the previous election being 3763, but this was reversed and the Liberal returned by a majority of 643. This is a clear indication that the strong war-time sentiment aroused over the question will not be appeased by the construction of a Canadian branch plant by the International Nickel Co. It was stated that the company had purchased a site for the plant at Port Colborne on Lake Erie, but it is now officially asserted that they have merely taken an option on a site there and that the question is still undecided. During the election campaign the Provincial government attempted to conciliate public opinion by announcing their intention of imposing increased taxation, retroactive in its operation, upon the International Nickel Co., which in the past has operated under a special agreement. A lease for the development of electric power on the Wahnapitae River has been granted by the Ontario government to the British Canadian Refining Co., lately organized, which proposes to establish a nickel-smelting works, using the electric process near their mine at Copper Cliff, at an outlay of several millions.

WESTERN AUSTRALIA.

EDNA MAY MINES.—The recent events at Westonia have attracted the attention of local mining circles. The development of chief importance is the cutting of the Edna May lode at the 480 ft. level in the Edna May Deeps. At this depth a cross-cut has been started, and an advance horizontal bore-hole has cut the lode, which assays 76s. over a width of 60 in. The cross-cut will be continued and the lode cut during the coming week.

The management of this company is to be congratulated on having carried out the work of sinking the shaft and coping with the water difficulties by the cementing method, which has not hitherto been used in Australia. The company had not the pumping plant necessary to deal with the heavy inflow of water, so the manager adopted the cement process. The method consisted of sinking a bore-hole 30 ft. in depth, with a $3\frac{1}{4}$ in. rock-drill. When completed, the hole was plugged with a $1\frac{1}{2}$ in. iron pipe with valve attached, covered with softwood used as a wedge, and firmly driven in. This pipe was then connected to the surface, and cement pumped in until the fissures around the hole were filled. A series of these holes was bored round the shaft, the cement allowed to set, then the shaft was sunk and the shots fired in the usual way.

The Edna May company has its new pumping plant doing good work, and is dealing with a flow of 40,000 gallons of water per hour. The erection of a Trent Californian decantation slime-plant has just been completed, and, although sufficient work has not yet been carried out to secure any data, there is every reason to believe that it will be a success. The large supply of water on this mine lends itself to the process, which, by its simplicity, is most economical in power, labour, and repairs. This process will be carefully watched by Western Australian metallurgists, and its results compared with the other methods of slime treatment now in vogue here.

At the Edna May Central the new lode has been cut at the 250 ft. level, and has been driven on for 40 ft., the average assay-value being 60s. over 72 inches.

Five miles to the west of the Edna May group, but along the same line of country, a small mine called the Edna May Battler is just ready to start crushing with a plant of five stamps. The lode at the 75 ft. level has been developed for a length of 240 ft. over a width varying from 18 to 48 in. worth 80s. per ton. There are several other smaller mines both to the east of the Battler and still farther west that are being opened up by parties of miners and small No Liability companies. Should only half of them become regular producers, the Westonia goldfield will materially compensate for the constantly decreasing output from the older producing districts.

The Edna May Central is at present a striking object lesson against the practice of sharebrokers sitting on the board of directors of mines. Last week, Richard Williams, the manager of the Edna May Central Co., who does not deal in shares, by a clerical error in coding reported a development as 9 oz. 8 grains per ton, instead of 9 dwt. 8 grains. This telegram arrived after the Stock Exchange had closed, but it was posted immediately by the directors as 9 oz. *8 dwts.*, with a foot-note saying that the telegram had been received in a mutilated condition, and that a wire had been despatched to the manager asking for confirmation of the figures. The manager, in the meantime, had found out his original error, and had wired correcting it in time to reach the board before the Stock Exchange opened. Had the directors held the mutilated telegram until they had received the confirmation, they would have been able to post the latter at the opening of the Stock Exchange. Instead of this, the posting of the original wire caused 25% appreciation in the value of the shares, and on receipt of the correction, a more than corresponding depreciation was recorded. As a result, the manager was immediately dismissed, after having carried out his work from the inception of the mine soundly and economically.

Mining engineers have big responsibilities, and are willing to shoulder them, but it is a serious blow to the profession if sharebrokers, acting as directors, can ruin the reputation of a manager for a clerical error, which was corrected before any harm could have been done.

KALGOORLIE.—The mines on the Golden Mile at present offer little in the way of news. The managers are faced with constantly increasing costs for supplies and decreasing efficiency in the men, owing to the younger and better men having enlisted. Under the circumstances, development work has in many cases to suffer, as outputs have to be maintained, and it is impossible to do both. It is only by the greatest care that the lower grade mines have been able to keep going during the past year. [Later news from Kalgoorlie appears in our Review of Mining.—EDITOR].

NULLAGINE.—The Nullagine Mining Company, which has a sluicing area of 530 acres in East Pilbarra, expects to have its plant going shortly. It is estimated that there is more than half a million cubic yards of gold gravel averaging 2s. 10d. per yard, and more than double that quantity of lower grade but still payable wash.

NEW YORK.

THREATENED STRIKE.—Through August attention was centred upon the threatened railroad strike, and when it was averted by action of Congress the debate shifted to whether the resulting industrial peace was worth the price. There can be no question but that the strike if it had come would have been a serious matter, and it came so close that many of the companies began to refuse to receive perishable freight. A tie-up of the railroads would have brought real hardship to the cities, especially since the daily transport of food is essential to them. It would also have interfered seriously with the trade of the country at what is thought to be a most critical period. Public opinion is divided as to where blame should be assessed. The men refused to allow their demands to be arbitrated, which offended the public, but there is more than a suspicion that the railway managers manipulated the crisis to make it as threatening as possible, and so that when they yielded it would be to public action rather than through any will of their own. In the United States railway rates are fixed by public officials, and the companies have made repeated but generally unsuccessful applications to be allowed to raise their rates. They have maintained, with much justice, that repeated increases in wages and in the cost of supplies, with stationary rates, have left them to face a diminishing margin of returns. If they are compelled by public action, as they have now been, to increase further the amounts paid their men, they will have strong grounds for a new appeal to the Interstate Commerce Commission for an increase in freight rates. In the end the public will pay the bill, which perhaps is not an unfair result since the public, by direct action or acquiescence, interfered on behalf of the men. In terms the demand was for an eight-hour day for train men, but since the present rate of pay, based upon 10 hours, is retained, this means an increase in many cases. Many of the men, however, are paid on a mileage basis, so it is not true, as has been stated, that a 25% increase has been granted. What would have occurred if a strike had come is hard to say. The last general railway strike, that of 1894, was broken by the use of Federal troops, but all the soldiers are now busy on the Mexican border, and to have withdrawn them for strike duty would have been a national disaster. Coupled with the new legislation is provision for a public inquiry into conditions, and it is by no means certain that because the present demands were granted so readily the way is open to indefinite repetitions of the manœuvre.

ZINC PRODUCTION continues to hold a large place in public attention despite the fall in the price of spelter. The drop had been so long anticipated and the price is still so much above normal that few have worried. It is true that at Joplin, where blende is down to \$60 to \$70 per ton, a number of the low-grade sheet-ground mines have closed. Other properties are, however, being brought in, especially along the western edge of the district where very rich orebodies are being developed. Wages have gone down to \$3·50 per day against the \$4·50 and \$5·00 that has been paid. As the men were on a sliding scale based upon the price of spelter, the reduction was accepted without much trouble. The growth of the American Zinc, Lead, & Smelting Company is the most remarkable feature of the American zinc industry in recent years. The company grew out of Boston investments made at Joplin during the boom times of 1899. It soon got into financial difficulties and its officers had no easy job in the following years. However they stuck to it, taking bad with the good and expanding as opportunity served. They acquired properties in Wisconsin and elsewhere and were the pioneers in the rejuvenation of the Tennessee zinc fields. An excellent new smelter was built at Hillsboro, Illinois, before the war and with the Tennessee ore it was found possible to make high-grade spelter so that full advantage was taken of the war prosperity. Since 1914 debts have been wiped out, big dividends paid, a surplus accumulated, and excellent properties bought. The company recently paid \$8,000,000 for the Granby Mining & Smelting Co., one of the pioneer American companies which has large land holdings and a lead smelter in Missouri with big zinc smelters in Kansas and Illinois. The American is also affiliated in some fashion with the Aetna Explosives Co., and the Butte & Superior, the most productive zinc mine in the United States. There are rumours that a large consolidation impends, and that in it Mr. D. C. Jackling and Hayden, Stone & Co. will have part. It seems probable that the American will attain, if it has not already done so, the position of premier zinc producer of the United States.

THE TREADWELL GROUP.—The directors of the Alaska Treadwell, Alaska United, and Alaska Mexican decided on August 7 on the terms of the consolidation of these properties. As already mentioned in the Magazine, Messrs. H. C. Perkins, Hennen Jennings, and F. W. Bradley examined the properties of the companies so as to be able to report as to the basis upon which they should be consolidated. They recommend an equitable basis for the consolidation as follows: Alaska Treadwell 54%, Alaska United 34%, Alaska Mexican 12%. In order to carry these recommendations into effect, it will be necessary to increase the capital stock of the Alaska Treadwell to 400,000 shares, of the par value of \$25 per share. To effect this increase the consent of 51% of the stock of the company will be required. When this consent is obtained the present shares will be exchanged for new shares. The distribution of this stock will be in the following ratio: 216,000 new shares for the 200,000 shares of present outstanding Alaska Treadwell stock, being at the rate of 1·08 new shares for one present share; 136,000 new Alaska Treadwell shares for the 180,200 shares of present outstanding Alaska United shares; 48,000 new Alaska Treadwell shares for the 180,000 shares of the present outstanding Alaska Mexican Company stock. The report of Messrs. Perkins, Jennings, and Bradley is to be printed and circulated. It sets forth the past history of the mines, their present condition, the future possibilities, and the suggested plans for future development and working.

PERSONAL

GLENN L. ALLEN, a leading American investigator of flotation, has been appointed metallurgist for the Shattuck-Arizona Copper Co. at Bisbee.

MAJOR ROBERT ANNAN, R.E., is making a speedy recovery after an operation for appendicitis.

E. A. ASHCROFT has moved his office to 65 London Wall, London, E.C.

H. FOSTER BAIN is leaving at the end of this month for China, by way of the United States.

C. J. BALDWIN has left for Mysore.

REGINALD F. BARKER has been appointed director of the Stawell School of Mines and Industries, Victoria.

E. A. BENSON has left for the Gold Coast.

J. W. BOYLE, of Dawson, Yukon Territory, has received a commission with the Canadian contingent, and has left for France.

MATTHEW TAYLOR BROWN has been elected a member of the board of the Transvaal Gold Mining Estates in succession to his brother, the late Nicol Brown.

J. W. BRYANT is now a lieutenant with Co. 258 R.E. with the British forces in Orama.

LIEUT. HARRY BUTTERS, nephew of Charles Butters, was killed in action in France while serving with the Royal Field Artillery.

JOHN CHAMPION, for many years chief accountant, and recently the secretary, of Dolcoath, died on August 19, aged 66 years.

DR. C. T. CLOUGH, of the Geological Survey of Scotland, was killed on the railway near Edinburgh, while engaged in investigations in connection with the coal measures.

H. A. COUSINS has left for Northern Nigeria.

PHILIP DEIDESHEIMER, who died in San Francisco on July 21, will be remembered as the deviser of the square-set system of timbering at Comstock, Nevada, in 1860.

J. T. DIXON, of the firm of Inder, Henderson, & Dixon, has gone to Colombia for the Anglo-Colombian Development Company.

THOMAS DRAPER left London on September 9 for New York, on his way to Cuba.

J. A. DRESSER is examining the Rice Lake district, Manitoba, for the Canadian Geological Survey.

C. H. EARLY is now manager at the Susanna Mine in Rhodesia.

S. W. FRENCH, manager of the Copper Queen, has been appointed general manager for Phelps, Dodge & Co. and will have his office at Douglas, Arizona.

E. C. GRAY has been appointed assistant manager of the Shropshire Lead Co.'s mines at Minsterley.

W. R. HAMILTON has changed his address from California street to Hobart Building, San Francisco,

J. A. L. HENDERSON has returned from a visit to Canada and the United States.

JAMES HOCKING, manager of the Cerro Muriano mines of the Cordoba Copper Co., in the south of Spain, is spending a vacation in Cornwall.

J. N. C. HUMPHREYS, of Chas. Butters & Co., is on his way from London to Chile.

J. P. HUTCHINS is expected to arrive in London from Petrograd on September 23.

CHARLES JANIN has returned to San Francisco from Alaska.

HENNEN JENNINGS, F. C. PERKINS, and F. W. BRADLEY have returned to San Francisco from Treadwell and are engaged in preparing their report on the consolidation of the Treadwell properties.

A. A. JONES is returning from Korea.

DR. WILLIAM R. JONES is now in Tavoy, Lower Burma, for the High Speed Steel Alloys company, in connection with the production of wolfram.

WALTER P. JOSHUA is on his way to England from Chota Nagpur, India.

CHARLES KIRCHHOFF, for many years editor of the *Iron Age*, and a past president of the American Institute of Mining Engineers, died on July 23.

WM. J. LAKELAND has resigned his position with the Burma Mines, Ltd., and has joined the Indian Army Reserve of Officers.

R. B. LAMB is in Nevada and California on a short visit.

JAMES G. LAWN is expected in Johannesburg in October.

R. J. LEMMON has left for West Africa.

ISAAC LEWIS has returned from New York.

V. F. STANLEY LOW is in the Aeronautical Inspection Service.

BERNARD MACDONALD has moved his office from Los Angeles to El Paso.

MALCOLM MACLAREN has returned from Korea.

ROLF MARSTRANDER, for the past four years mining engineer to Uruguayan Government, has returned to Christiania, Sweden.

E. T. MCCARTHY has gone to Russia for a few weeks.

JAMES MILLER is home from Brazil.

WILLIAM NICOL has resigned the professorship of mineralogy in the Queen's University, Canada.

F. M. PERKINS has gone from Chile to South Africa.

ARTHUR JAMES PETERSON has received the D.S.O. He fought his battery for five days and nights within 400 yards of the enemy's lines in spite of heavy retaliations.

WILLIAM B. PHILLIPS has resigned as president of the Colorado School of Mines, and is now devoting his attention to kaolin deposits in Texas. He is succeeded by H. C. PARMELEE.

C. W. PURINGTON is intending to sail from New York on September 19, on his return to London.

A. BASIL REECE has gone to Jos, Northern Nigeria.

T. A. RICKARD is visiting British Columbia.

THOMAS RICKARD has left Newquay for the Spassky copper mine, Siberia.

J. A. ROBERTSON is travelling in Sze Chuan.

BERNARD H. SANDERS has returned from Brazil.

FRED SEARLS jr., on his return to the United States from the Transvaal, has gone to China.

HOWARD SMITH has left for New York and San Francisco.

W. F. STEVENS has returned to London after spending two years in Russia and Siberia on examination work.

HENRY C. TAYLOR has gone abroad.

ROBERT THOMSON has returned from Siam.

VALERIUS, MCNUTT, & HUGHES have moved their office from Clinton Building to 318-319 Mayo Building, Tulsa, Oklahoma.

W. B. VANDERLIP is in London from California.

D'ARCY WEATHERBE has gone to Canada from Russia and is expected in England shortly.

L. J. WILMOTH has returned to the Ashanti gold mine, West Africa.

H. C. WOOLMER has been in London for a short stay.

WONHAM, BATES, & GOODE, of 3 London Wall Buildings, London, E.C., now represent the Hammond Iron Works of Warren, Pennsylvania.

POPE YEATMAN has resumed independent practice as a consulting mining engineer, with offices in New York.

METAL MARKETS

COPPER.—The market has been firm throughout the month without any sensational rise in quotations, but the actual tonnage dealt in on the London Metal Exchange has been insignificant. Official markings are consequently rather easily controlled. In rough copper for sulphate making, considerable business has been put through, both in this country and in Italy. A large deal is reported to have taken place for the Allied governments with American refiners in electrolytic copper to follow existing contracts, and active business has been done in Japanese copper for Russia. Altogether Japanese refined brands are very much in evidence at present, and are coming into favour with European consumers. American producers are once more in a very independent position in spite of an increased output. Consumers are consequently compelled to pay high prices to obtain supplies. The forward position is easier, but no inquiry has developed ahead. The threat of a railway strike in America made both producers and buyers cautious. The American electrolytic quotation has risen to 27¾ to 28c. f.o.b. New York. Consumption in this country continues on an important scale, and consumers do not seem to be too well provided. The latest price for electrolytic here is £131–£129. Standard closes at £110. 10s. cash, and £107. 10s. three months, after being dealt in as high as £116.

Average prices of cash standard copper: August 1916, £110. 8s. 3d.; July 1916, £95. 0s. 9d.; August 1915, £68. 15s. 1d.

The following were the quotations for copper and brass on September 8: Tough copper £121–£125 per ton, best selected £123–£127, India sheets £150, American electrolytic wire bars £133, cathodes £132 15s.; solid drawn tubes 18¾d. per lb., brazed tubes 18¾d., wire 18d., yellow metal 14½d.; solid drawn brass tubes 15¾d. per lb., brazed tubes 17¾d., rods 15⅝d., sheets 15⅝d., wire 14⅞d. Sulphate of copper £50 per ton. The daily London prices of standard and electrolytic copper are given in our pages of statistics.

TIN.—Trading has been light and prices steady around £170. Only 70% of English tinplate mills are in operation, and a further reduction is anticipated. In America purchases are held back, and a reserve of buying power is consequently accumulating. Speculation is absent, and the market, being left to its own fate, is devoid of special feature. In this connection it is to be remembered that the market has always shown resistance to a further fall when prices have reached their present level. Export licences are being granted with great reserve, which ensures a plentiful supply here, but a deficiency elsewhere. In Java sellers are holding back. Business in Banca and Billiton has been fostered with the United States for direct shipment by the British export regulations.

Average prices of cash standard tin: August 1916, £169. 19s. 9d.; July 1916, £168. 9s. 6d.; August 1915, £151. 12s. 10d.

SPELTER.—The market has been firm and prices have risen from £47–£42 to £58–£45. A fair business has been done. First hands appear to be sold out for delivery before October-November, and spot sales are reported round £60. The threatened railway strike in America, while adversely affecting prices there, created an uncomfortable position here in view of the dependence on American supplies. Efforts are being made to reduce the quotation in London.

Average prices of good ordinary brands: August 1916, £47. 19s. 7d.; July 1916, £48. 7s. 6d.; August 1915, £67. 15s. 9d.

LEAD.—Lead has shown a good deal of strength, not so much because of an active demand as on account of the reserve on the part of sellers. Arrivals of metal for sale have been notably small, but the control exercised by the authorities has been sufficient to keep prices from becoming unduly inflated. The quotation has risen in America from 6c. to 6½c., and in this country from £28. 10s.–£28 to £31–£30. A somewhat easier tendency is now being shown.

Average prices of soft foreign lead: August 1916, £29. 2s. 7d.; July 1916, £27. 8s. 11d.; August 1915, £21. 18s. 11d.

ANTIMONY.—There is no new business to report, so that the quotations are purely nominal. The Government price continues at £95 per ton; £42 has been mentioned as a price for crude. In the United States the market had been weak for some time, and at one time the price sank as low as 10 cents per pound, equivalent to £46 per ton. This low level of prices served to induce business, and the demand from ammunition makers became strong. The quotation jumped to 16 cents, but subsequently fell again to 14 cents.

QUICKSILVER.—The quotation for Spanish quicksilver continues at £17 15s. per flask of 75 lb, and the market has been devoid of feature. The American price has continued to become easier, and now stands at about $75, as compared with $80 a month ago and $135 earlier in the year.

BISMUTH.—This metal continues under the control of the Government, being required for the manufacture of fusible metals. The figure at which sales are effected on contract is around 11s. per pound, but new customers, if they get any at all, will probably have to pay 15s.

CADMIUM.—The Government has made restrictions in the export of cadmium and its alloys, and the price has weakened slightly to 7s. 6d. per pound. Cadmuim is used in the manufacture of fusible metals, a fact which explains the Government's action. Two papers have been published recently on the properties of cadmium and its effects on other metals, one by the American Society for Testing Materials and the other by the Institute of Metals. We hope to quote from these papers in our next issue.

PLATINUM.—The Government buying price has been raised from 190s. to 200s. per ounce, and the selling price is fixed at 220s. In America the demand has increased, and buying orders have come in. The price is quoted at $62½ to $65.

NICKEL.—The quotation for nickel in this country continues at £225 per ton. In the United States the price is steady at 45–50 cents per pound; electrolytic nickel brings 5 cents per pound more.

ALUMINIUM.—The market continues without any feature of interest. The Government still controls the market with the price at about £150. In America the price remains at 50 to 60 cents per pound.

IRON.—The iron and steel trades continue under the rigid control of the Government committee, and consumers only obtain their current requirements. The stocks of pig iron continue to shrink. The demand for hematite pig is as strong as ever, the French demand being particularly pressing. Additional furnaces are being gradually blown in. The price of Spanish ore delivered is 38s. per ton, of which 17s. goes as freight charges. The quotations of pig iron are as follows: Cleveland No. 3 87s. 6d. (control), 97s. 6d. for small lots, East Coast hematite mixed numbers 127s. 6d., West Coast hematite mixed numbers 127s. 6d., South Staffordshire cold blast 182s. 6d. Other quotations are: steel rails £10 17s. 6d., ship plates, Middlesbrough £11 10s., ditto for export £14 5s., galvanized sheets £28 15s., tin plates Bessemer I.C. cokes South Wales 35s. 6d. (per box).

COAL AND COKE. — The South Wales steam-coal trade is congested and deliveries are greatly delayed. No quotation is given for the best qualities and best sizes, but second grades bring 40s. per ton. Anthracite at Swansea is quoted at 32s., and best steam coal at Newcastle 45s. The control price of furnace coke in South Wales is 30s., but odd lots from stock bring 50s. North of England coke is quoted at 28s.

MANGANESE.—Indian manganese ores on 50% basis delivered in England next year are quoted at 2s. 5½d. per unit, and Brazilian ores at 4s. In America, Brazilian ores are quoted at 65 cents per unit delivered at a United States port. The development of Virginia ores continues and good prices are obtained. Ferro-manganese 80% is quoted in the North of England at £25 per ton; for export the price varies from £30 to £40. American steel manufacturers are not so anxious as they were and spot supplies appear to be obtainable at £35 to £40 per ton. Metallic manganese is quoted in Sheffield at 4s. per pound 90–95% carbonless.

TUNGSTEN. — For some time the Government's price for wolfram and scheelite was 55s. per unit on the basis of 70% WO_3. These prices are now withdrawn and no official figures of price are given. The control price of high-speed tool steel is as follows: finished bars 14% tungsten 2s. 10d. per pound, 18% tungsten 3s. 10d.; scrap is re-purchased at 5d. per pound for millings and turnings, and 6d. for bar ends. Ferro-tungsten is quoted at 6s. 1d. per pound, and tungsten metal powder 96–98% 6s. 3d. per pound.

MOLYBDENUM.—The Government's price of 105s. per unit for molybdenite basis 90% MoS_2 has been withdrawn and no prices are now given. Ferro-molybdenum 65–80% Mo is quoted at 16s. per pound.

TITANIUM.—The Sheffield quotation of ferro-titanium 15–18% Ti and 5–8% carbon is 6½d. per lb.; 23–25% Ti carbonless 1s. 5d. per lb.

FERRO-SILICON.—Basis 75% Si £48 per ton, scale 8s. per unit; 45–50% basis 45% £28 10s. per ton, scale 7s. 6d. per unit.

COBALT.—96–98% 7s. 6d. per pound.

VANADIUM.—Ferro-vanadium is quoted in Sheffield at 15s. per pound of vanadium contained. The American Vanadium Company, which has built up a good business in ore, metal, and steel has got into the control of the financiers who have expanded the capitalization in the usual way. The capitalization was $700,000, and in the future it is to be $13,500,000, consisting of $5,000,000 7% preferred stock, $6,000,000 common stock, and $2,000,000 6% short term notes.

CHROMIUM.—Chalas & Sons, London, give the following quotations for chrome ores: New Caledonia ore 53–55%, basis price for 50% Cr_2O_3, 37s. 6d. per ton f.o.b., scale 2s.; Baluchistan ore (last sale) 53–55% 60s. per ton f.o.b.; no quotation is published for Rhodesian ore 48–52% or 47%. At Sheffield the quotations for ferro-chrome are: 4–6% carbon, basis 60% £38 per ton, scale 12s. 6d.; 6–8% carbon basis 60% £36 per ton, scale 10s.; 8–10% carbon basis 60% £34 per ton, scale 10; specially refined, maximum 20% carbon basis 60% £120 per ton, scale 32s. 6d.; metallic chromium 92–99% 5s. 9d. per pound.

SILVER.—The silver market has been firm during the past month, owing partly to the steadiness of Chinese exchange. The price has varied within narrow limits, and on one day at the beginning of September stood at 32½d., the highest price for three months. As the stocks in England and India are small and the coinage requirements continue there is no reason to expect any weakness in price in the near future.

PRICES OF CHEMICALS. September 8.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	8	0
,, 60%	,,	3	11	0
,, Glacial	,,	9	10	0
Alum	per ton	14	0	0
Alumina, Sulphate of	,,	19	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	14	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	36	0	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bisulphide of Carbon	,,	30	0	0
Bleaching Powder, 35% Cl.	,,	18	0	0
Borax	,,	33	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	50	0	0
Creosote	per gal.		0	4
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	5	0
Lead, Acetate of, white	,,	90	0	0
,, Chemical Sheet Metal	,,	39	0	0
,, Nitrate of	,,	68	0	0
,, Oxide of, Litharge	,,	43	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	7
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	6
,, Carbonate	per ton	150	0	0
,, Chlorate	per lb.		2	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb		7	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	0
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	75	0	0
,, Bicarbonate	,,	6	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	18	0	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 95%	,,	18	0	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	15	0
,, Sulphide	,,	20	0	0
Sulphur, Roll	,,	13	0	0
,, Flowers	,,	14	10	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tartaric Acid	per lb.		3	0
Tin Chloride (Tin Crystals)	,,		1	4
Zinc Chloride, solution 100°T.	per ton	31	0	0
Zinc Sulphate	,,	27	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767
July	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1915	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247
May	2,382,298	26 7	18 2	8 2	977,263
June	2,296,520	27 0	18 3	8 6	977,681

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	333,070	135,289	127,107
July	336,565	322,365	140,290	128,574
August	344,493	—	139,364	—
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	2,286,337	1,706,473	953,938

Production of Gold in Western Australia.

	Export oz.	Mint oz.	Total oz.	Total value £
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181
July	555	98,859	99,414	422,271
August	*	89,522	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	72,200	18,000
July	154,800	100,600	88,830	85,400	23,000
August	80,300	—	93,050	—	24,000
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	636,100	1,078,560	579,800	253,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	191,404
August	193,998	196,560	197,984	192,784
September	191,642	195,843	195,952	—
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	1,524,358

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard	Silver
Aug.	£ s. d.	£	£ s. d	£	£ s. d	d.
1	108 10 0	127	28 7 6	55	167 5 0	30½
2	106 10 0	127	28 10 0	50	167 10 0	30½
3	106 10 0	127	28 10 0	47	168 0 0	30⅞
4	106 0 0	127	28 10 0	47	168 10 0	30 13/16
7	106 10 0	126	28 15 0	47	167 10 0	31 7/16
8	107 0 0	126	28 15 0	44	167 10 0	31⅝
9	109 0 0	126	29 2 6	47	168 0 0	31 5/16
10	110 10 0	126	29 2 6	47	169 10 0	31⅝
11	112 0 0	126	29 5 0	49	171 0 0	31⅝
14	115 10 0	127	29 7 6	49	173 10 0	31¾
15	115 10 0	128	29 15 0	49	172 5 0	31¾
16	115 0 0	128	30 0 0	49½	171 0 0	31 11/16
17	114 10 0	128	29 12 6	53	171 10 0	31 9/16
18	112 10 0	128	29 15 0	54	169 5 0	31 5/16
21	110 10 0	128	29 17 6	55	169 10 0	31 7/16
22	110 10 0	128	29 17 6	55	169 0 0	31 9/16
23	109 15 0	129	30 0 0	55	169 5 0	31⅝
24	109 5 0	130	30 7 6	57	170 0 0	31⅝
25	110 5 0	130	30 7 6	58	170 15 0	31 9/16
28	110 15 0	130	30 10 0	58	172 15 0	31 11/16
29	110 0 0	130	30 15 0	58	173 0 0	31 13/16
30	110 0 0	131	31 0 0	54	171 0 0	32
31	109 10 0	131	31 0 0	52	170 15 0	32
Sept.						
1	110 5 0	131	31 0 0	49	170 5 0	32 7/16
4	110 5 0	131	30 15 0	49	170 5 0	32⅛
5	109 10 0	131	30 10 0	49	170 15 0	32⅜
6	109 0 0	131	30 5 0	48½	171 0 0	32½
7	109 15 0	132	30 5 0	48½	170 15 0	32 5/16
8	110 5 0	132	30 5 0	50	169 15 0	32½

IMPORTS OF ORES AND METALS INTO UNITED KINGDOM.
Long tons.

	Year 1915	July 1916	Aug. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	2,962	2,285	22,633
,, Matte and Precipitate	38,372	2,208	4,922	29,644
,, Metal (unwrought and part wrought)	180,368	9,252	10,492	79,545
Copper and Iron Pyrite	903,401	95,302	98,775	708,202
Tin Concentrate	44,748	2,279	5,182	23,363
,, Metal	38,896	3,306	2,895	23,963
Manganese Ore	377,324	33,817	46,696	306,005
Lead, Pig and Sheet	256,476	5,916	14,960	108,804
Zinc (spelter)	74,520	4,884	6,060	30,741
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	270,249	17,400	2,396,939

STOCKS OF COPPER.
Reported by Henry R. Merton & Co. Ld. Long tons.

	June 30, 1916	July 31, 1916	Aug. 31, 1916
	Tons	Tons	Tons
Standard Copper in England	2,148	1,382	1,870
Fine Copper in England	2,070	2,058	2,969
,, ,, Havre	3,385	2,525	2,675
,, ,, Afloat from Chile	2,225	2,175	850
,, ,, ,, from Australia	4,000	3,500	3,150
Total Visible Supply	18,951	16,763	16,637
Fine Copper in Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*

* As on July 31, 1914, but presumably present stock nil.

EXPORTS OF COPPER FROM UNITED STATES
Reported by United States Customs.

1915	Long tons	1916	Long tons	1916	Long tons
July	16,812	January	21,863	July	35,048
August	16,289	February	20,548	August	—
September	14,327	March	24,006	September	—
October	26,153	April	19,980	October	—
November	19,396	May	14,700	November	—
December	32,936	June	38,277	December	—
Total 1915	257,915			Total 1916	174,422

STOCKS OF TIN.
Reported by A. Strauss & Co. Long tons.

	June 30, 1916	July 31, 1916	Aug. 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,537	1,074	1,701
Ditto, Landing and in Transit	225	1,190	1,175
Other Standard, Spot and Landing	1,399	1,595	1,260
Straits, Afloat	5,125	3,640	3,145
Australian, Afloat	500	500	385
Banca, on Warrants	—	—	—
Ditto, Afloat	3,640	1,067	753
Billiton, Spot	—	—	—
Ditto, Afloat	400	393	477
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,450*	1,825*	1,291*
Afloat for United States	3,325	4,667	4,705
Stock in America	3,963	5,028	4,758
Total Stock	21,564	20,979	19,648

* Including 705 tons on board enemy's ships either captured or lying in neutral ports.

SHIPMENTS AND IMPORTS OF TIN.
Reported by A. Strauss & Co. Long tons.

	Year 1915	July 1916	Aug. 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	1,860	2,370	18,515
Straits to America	31,565	2,530	1,490	17,920
Straits to Continent	11,024	1,020	666	5,876
Australia to U.K.	2,481	119	63	1,852
U.K., Holland, and Continent to America	14,967	2,137	1,550	10,358
Imports of China Tin into U.K. and America	3,012	—	—	1,190
Imports of Bolivian Tin into Europe	22,591	1706	2,822	10,099

NIGERIAN TIN PRODUCTION.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	510
July	140	357	432	455	506
August	201	406	228	438	—
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	3,644

PRODUCTION OF TIN IN FEDERATED MALAY STATES.
Estimated at 70% of Concentrate shipped to Smelters.
Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	3,517
August	4,454	4,620	3,591	4,046	3,732
September	4,115	4,379	3,623	3,932	—
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	28,974

SALE OF TIN CONCENTRATE AT REDRUTH TICKETINGS.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
September 27	171½	£14,459	£84 6 3
October 25	164	£13,981	£85 5 0
November 8	175	£15,687	£89 12 9
November 22	174¾	£16,842	£96 7 8
December 6	182¼	£16,803	£92 4 0
December 20	181½	£16,941	£93 6 10
Total, 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10
July 17	186½	£17,114	£91 15 4
July 31	172¼	£16,172	£93 17 8
August 14	166	£15,955	£96 2 4
August 28	180¼	£17,345	£96 4 8

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:

	Sept. 1 1915	Aug. 4 1916	Sept. 5 1916
Rand:			
Bantjes	6	14	16
Brakpan	59	90	89
Central Mining (£12)	130	127	127
Cinderella	3	6	6
City & Suburban (£4)	42	39	36
City Deep	61	80	85
Consolidated Gold Fields	24	31	34
Consolidated Langlaagte	38	32	29
Consolidated Main Reef	20	19	17
Consolidated Mines Selection (10s)	9	18	20
Crown Mines (10s.)	77	60	51
Daggafontein	8	15	16
D. Roodepoort Deep	15	14	14
East Rand Proprietary	22	14	15
Ferreira Deep	42	27	27
Geduld	32	44	43
Geldenhuis Deep	20	26	23
Gov't Gold Mining Areas	23	40	47
Heriot	55	47	47
Jupiter	5	8	8
Kleinfontein	22	28	32
Knight Central	7	14	13
Knight's Deep	25	25	29
Langlaagte Estate	17	19	17
Luipaard's Vlei	6	8	8
Main Reef West	6	7	8
Meyer & Charlton	101	106	104
Modderfontein (£4)	230	349	377
Modderfontein B	106	136	136
Modder Deep	99	136	150
Nourse	21	15	17
Rand Mines (5s.)	82	72	69
Randfontein Central	11	10	11
Robinson (£5)	28	24	16
Robinson Deep	22	25	35
Rose Deep	34	26	22
Simmer & Jack	8	7	6
Simmer Deep	1	2	2
Springs	26	58	57
Van Ryn	52	40	39
Van Ryn Deep	50	75	69
Village Deep	36	31	32
Village Main Reef	26	15	13
Witwatersrand (Knight's)	60	60	55
Witwatersrand Deep	30	27	22
Wolhuter	12	10	11
Other Transvaal Gold Mines:			
Glynn's Lydenburg	11	15	15
Sheba (5s.)	3	2	2
Transvaal Gold Mining Estates	34	25	24
Diamonds in South Africa:			
De Beers Deferred (£2 10s.)	212	222	254
Jagersfontein	52	66	79
Premier Diamond Defer'd (2s. 6d.)	85	102	110
Rhodesia:			
Cam & Motor	12	13	11
Chartered	10	13	13
Eldorado	9	10	9
Enterprise	4	5	5
Falcon	7	14	14
Giant	5	6	7
Globe & Phœnix (5s.)	27	25	28
Lonely Reef	20	24	21
Shamva	36	30	32
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	4	5	5
West Africa:			
Abbontiakoon (10s.)	8	7	6
Abosso	8	9	9
Ashanti (4s.)	16	19	18
Prestea Block A	9	9	8
Taquah	14	19	20
West Australia:			
Associated Gold Mines	4	4	3
Associated Northern Blocks	4	3	3
Bullfinch	6	4	4
Golden Horse-Shoe (£5)	41	37	36
Great Boulder Proprietary (2s.)	15	13	13
Great Boulder Perseverance	1	1	1
Great Fingall (10s).	2	2	1
Ivanhoe (£5)	43	44	42
Kalgurli	30	12	12
Sons of Gwalia	17	15	15
Yuanmi	2	2¾	2

Gold, Silver, *cont.*	Sept. 1 1915	Aug. 4 1916	Sept. 5 1916
Others in Australasia:			
Blackwater, New Zealand	15	15	13
Consolidated Gold Fields of N.Z.	11	6	6
Mount Boppy, New South Wales	7	14	10
Progress, New Zealand	5	4	3
Talisman, New Zealand	21	12	11
Waihi, New Zealand	35	42	42
Waihi Grand Junction, New Z'lnd	21	19	19
America:			
Alaska Treadwell (£5), Alaska	136	115	107
Buena Tierra, Mexico	10	13½	13
Camp Bird, Colorado	5	8	8
Canadian Mining, Ontario	8	12	10
Casey Cobalt, Ontario	6	6	5
El Oro, Mexico	7	9	9
Esperanza, Mexico	7	11	12
Frontino & Bolivia, Colombia	9	11	11
Le Roi No. 2 (£5), British Columbia	12	10	10
Mexico Mines of El Oro, Mexico	70	72	72
Oroville Dredging, California	14	16	17
Plymouth Consolidated, California	18	23	23
St. John del Rey, Brazil	15	16	15
Santa Gertrudis, Mexico	7	12	12
Tomboy, Colorado	20	22	22
Russia:			
Lena Goldfields	30	36	39
Orsk Priority	9	22	26
India:			
Champion Reef (2s. 6d.)	11	6	6
Mysore (10s.)	79	77	75
Nundydroog (10s.)	25	26	27
Ooregum (10s.)	22	21	21

COPPER:

	Sept. 1 1915	Aug. 4 1916	Sept. 5 1916
Anaconda (£10), Montana	155	340*	357
Arizona Copper (5s.), Arizona	36	40	41
Cape Copper (£2), Cape Province	55	80	80
Chillagoe (10s.), Queensland	½	½	¼
Cordoba (5s.), Spain	2	3	3
Great Cobar (£5), N.S.W.	2	3	3
Hampden Cloncurry, Queensland	27	36	36
Kyshtim, Russia	36	51	55
Messina (5s.), Transvaal	14	11	11
Mount Elliott (£5), Queensland	57	77	79
Mount Lyell, Tasmania	21	26	26
Mount Morgan, Queensland	41	37	37
Rio Tinto (£5), Spain	1100	1225	1235
Sissert, Russia	20	26	22
Spassky, Russia	39	43	42
Tanalyk, Russia	37	52	55
Tanganyika, Congo and Rhodesia	24	50	50

LEAD-ZINC:

	Sept. 1 1915	Aug. 4 1916	Sept. 5 1916
Broken Hill:			
Amalgamated Zinc	22	33	31
British Broken Hill	19	24	26
Broken Hill Proprietary (8s.)	42	61	60
Broken Hill Block 10 (£10)	20	23	24
Broken Hill North	36	46	47
Broken Hill South	120	170	166
Sulphide Corporation (15s.)	17	26	26
Zinc Corporation (10s.)	11	15	16
Asia:			
Burma Corporation	33	66	75
Irtysh Corporation	32	50	50
Russian Mining	16	24	21
Russo-Asiatic	80	124	125

TIN:

	Sept. 1 1915	Aug. 4 1916	Sept. 5 1916
Nigeria:			
Bisichi	5	8	8
Ex-Lands Nigeria (2s.)	1	1	1
Mongu (10s.)	7	8	8
Naraguta	12	14	14
N. Nigeria Bauchi (10s.)	2	2	2
Rayfield	3	5	6
Ropp (4s.)	14	16	16
Other Countries:			
Aramayo Francke, Bolivia	26	27	27
Briseis, Tasmania	4	5	4
Cornwall Tailings, Cornwall	12	4	3
Dolcoath, Cornwall	6	11	10
East Pool, Cornwall	8	36	35
Gopeng, Malay	26	30	30
Pahang Consolidated (5s.), Malay.	6	11	12
Renong Dredging, Siam	20	30	30
Siamese Tin, Siam	56	51	56
South Crofty (5s.), Cornwall	5	16	15
Tekka, Malay	55	62	65
Tronoh, Malay	31	30	29

* Denomination of shares recently changed from £5 to £10.

THE MINING DIGEST

A PRECIS OF MINING TECHNOLOGY, DEVELOPMENT, AND LITERATURE

[*In this department will be found listed the more important articles and miscellaneous publications appearing each month which deal with metal mining and non-ferrous mineralogy, the more significant publications being abstracted or reviewed. Copies of the originals can be obtained through the Technical Bookshop, Salisbury House, London, E.C., the book department of The Mining Magazine.*]

THE RICE LAKE DISTRICT, MANITOBA.

In our last issue we made brief mention of the Rice Lake district in Manitoba, to the southeast of Lake Winnipeg, where gold deposits are now being developed. Further information is contained in an article by Justin S. De Lury, published in the *Canadian Mining Journal* for August 1. The author points out that the Rice Lake deposits are only members of a greater group, and that though their existence has been known for some years, other deposits at Gold Lake and Long Lake have attracted equal attention lately. Thus he prefers to refer to the larger area as the Manigotagan district, owing to the river of this name affording the means of access.

Examinations of the district were made for the Canadian Geological Survey by Moore and Wallace in 1912. Moore's map gives a general idea of the geological relations of the country. In the accompanying sketch, based on Moore's map, no attempt has been made to represent the geological formations; it is presented merely to add some topographic and geologic features not found in Moore's map and to indicate the general locations of the prospect camps mentioned by the author. A broad belt of Pre-Cambrian rocks from a few miles to 10 or 12 miles in width and from 60 to 80 miles in length, extends from the mouth of the Hole or Wanipigow River on Lake Winnipeg in a southeasterly direction. The nature of these rocks is indicated by Moore's classification given below; the belt is surrounded on all known sides by granites, intrusive at least into some of the formations. The bedding planes of the old sediments and the schistose layers of the more massive rocks are generally nearly vertical in position, suggesting that they are the remains, in part at least, of the synclinal portions of the isoclinal folds. The strike of these folds is roughly parallel to the lines of contact of the belt throughout the district.

Moore's classification of the rocks is as follows:
Post-Lower Huronian?—Manigotagan Series: pegmatite and gneiss.

Huronian?—Wanipigow Series: conglomerate, arkose, greywacke, chert, jasper, grey gneiss, and schist.

Keewatin—Rice Lake Series: greenstone, quartz porphyry, rhyolite, trachyte, felsite, green and grey schist.

Moore places the porphyry with the Rice Lake Series, which is placed provisionally as of Keewatin age. This was done probably from its general close connection with Keewatin greenstone and from the fact that large portions of the porphyry might well appear as probable lava rocks and from the finding of similar rocks as pebbles in the conglomerate. It was found that the porphyry, and apparently the ore that is general throughout the district, is intrusive into the greenstone; and more conclusive still, it was found to intrude sediments which almost certainly belong to Moore's Wanipigow Series, which is regarded as younger than the Rice Lake Series. Thus, the porphyry is, next to the granite, the youngest large formation of the district. The relative ages of the formations are fairly well established, but no correlation can be attempted until the granites are differentiated and the relations of the different masses with the other rocks are established. All the contacts observed show that the granite is the latest formation. Whether there is an older granite which is not later than some of the Pre-Cambrian rocks has not been determined, so that it is inadvisable to read any of these formations too closely into established Pre-Cambrian classifications. There is one important body of granite not indicated on Moore's map, but is added on Mr. De Lury's sketch. It contains some of the veins of the Long Lake-Halfway Lake area, where it intrudes greenstone and porphyry on the southwest side and greenstone on the northeast side. Near the Moose vein in the Gold Lake area there is a similar granite, and possibly the two outcrops may belong to the same body. The greenstones of the area show types from fine-grained lava showing pillow structure to fairly coarse diabase. All of these are more or less chloritic and show various depths of green colour, but they are not necessarily all of the same age or all Keewatin. Detailed field work is now being undertaken by the Survey to determine many unsolved points in the geology of the district.

As regards the gold deposits in the Rice Lake area, rich ore has been found in several places, but the veins appear to be irregular, breaking up and pinching out at intervals. Little adequate surface prospecting or stripping has been done, but the veins were followed downward. Most of the machinery employed has since been transferred to the Gold Lake area. In the latter district three properties have been developed fairly extensively, the Gold Pan, Gold Seal, and the Moose. Shafts have been sunk at the Gold Pan and Gold Seal. At the Gold Pan, phenomenally rich ore was found at a depth of 125 ft., where a basic dike cuts across the porphyry. Whether there was any connection between the rich ore and the porphyry is not determined. At the Moose, operations are under the direction of John Redington, formerly of Copper Cliff and Cobalt. A shaft has been sunk 100 ft. and drifts along the vein in both directions are in hand.

The veins in Gold Lake area are in porphyry of a fairly acid type, grading from a fine-grained felsite to coarse quartz and felspar porphyries. The quartz occupies greatly sheared zones in the country rock, and while fairly continuous varies considerably in width and massiveness. The width varies from a few inches to 6 ft., and the veins are occasionally split into several by masses of schistose country rock. The veins are nearly vertical, and their strike approximates to the schistosity of the country rock, which in turn is always roughly parallel to the general outcrop of the rock formation. In the country between the east end of Long Lake and Halfway Lake there are some veins similar in many ways to those in the Gold Lake area. The difference between the two areas is that some of the more promising veins near Halfway Lake are in granite occupying sheared zones similar to those containing porphyries in the Gold Lake area. In the quartz of the Gold Lake and the Long Lake areas some free gold is generally visible. Pyrite or chalcopyrite generally accompanies the free gold. Molybdenite, galena, and zinc-blende are found in bunches and grains. Calcite is found in many outcropping veins and is associated with galena and blende. In both areas veins have been traced for considerable distances, two of them for over 2000 ft., but as the entire length of these veins has not been stripped, the continuity of the exposures cannot be said to be definitely proved.

In discussing the possibilities of the district, Mr. De Lury says that there is a large belt of country throughout which gold is found, well distributed in quartz veins and accompanied by sulphides. As a rule there is some mineralization of the country rock, and in places, notably in the Rice Lake area, this is pronounced. Though none of the prospects can as yet be regarded as mines, some may become producers, and the wide distribution of the gold augurs well for future prospecting. No formation can be said to be obviously the most favoured, and practically all the large formations carry gold-bearing quartz. Probably, however, if a choice is to be recommended, it may be said that the porphyry and granite offer the greatest chances.

ORIGIN OF THE LAKE SUPERIOR COPPER DEPOSITS.

The State of Michigan has recently published a modest little report upon the copper deposits of the northern peninsula, written by R. E. Hore, formerly of the Michigan College of Mines and now editor of the *Canadian Mining Journal*. In it will be found the only comprehensive summary of existing knowledge of the deposits available, and the description of the individual lodes is especially helpful to those who would get clearly in mind the main characteristics of this important district in which, as we may remark in passing, the general geology is most like that of the Rand. In view of the differences of opinion regarding the origin of the copper deposits, Mr. Hore's conclusions are especially interesting. We summarize them as below.

Before any hypothesis can be weighed it is necessary, as Mr. Hore points out, to get into mind certain characteristics of the deposits. The copper occurs almost entirely as native metal, only a little being in the forms of arsenides and sulphides in fissure veins. The associated minerals are calcite, quartz, delessite, chlorite, epidote, prehnite, and iron oxides. The copper occurs in the parts of the rock that have been decomposed, some as fillings of fissures and pores, and some in fractures with and transverse to the bedding, but most of it as a replacement. In the amygdaloids a minor part occurs in the amygdules and in the conglomerates; most of it is in the matrix, but a part in the pebbles. The deposits are all in the Keweenaw series of rocks and all but one are in the lower, most igneous portion. Most are in the amygdaloids, but the richest is the Calumet conglomerate which is interbedded with volcanic rocks. Many of the deposits have thick, relatively impervious trap rocks overlying them. The amygdaloid rocks are themselves thick beds, mostly ophites, and commonly are now a greenish mass of secondary minerals.

Mr. Hore concludes that the copper and the igneous rock had a common origin and considers two hypothesis: (1) That the copper was deposited with the rock constituents, perhaps as a silicate, and subsequently dissolved, concentrated, and reprecipitated; and (2) that it is essentially a primary deposit from solutions that accompanied extrusion of the lava. He considers the latter hypothesis to be the better grounded. The abundance of chlorides in the mine waters and absence of sulphides argues against a derivation by concentration of disseminated sulphides, and the character of the accompanying minerals—chlorite, epidote, calcite, quartz, prehnite, and hematite—is appealed to as evidence that the replacement was accomplished by hot magmatic rather than meteoric waters. The rocks were certainly fractured and possibly tilted before deposition of native copper ceased. It is possible that very little deposition took place before the rocks were extensively fractured, but the deposits are believed to have been formed in Keweenawan time. The fracturing of the rocks was an important factor in determining the nature of the deposits. As to changes with depth he says: "Before any useful deductions regarding the deposition of the copper can be made from the falling off of values with depth, it is necessary to consider the facts more carefully. It is true that the ore now being mined at great depth is much leaner than that mined at some higher levels; but reference to descriptions of the various lodes will convince the reader of the inaccuracy of the general statements of gradual decrease with depth. The richer portions have terminated at some depth of course; but they terminate laterally in just the same way. There is no marked difference between the falling off in values with increase in depth and the falling off in values that is found in extending the openings laterally. Because some of the lodes are being mined for several miles, it must not be imagined that the orebodies are continuous. Rich and poor ground alternate. At and near the surface the lodes have been tested at intervals and the richer minable portions discovered. There is unfortunately no means of locating any orebodies which may lie at some distance below the present mine openings. The statement that the deep openings on the most productive lodes are in much leaner ore than was mined years ago is unfortunately only too true. It is one that has taken longer to determine for depth than for length. There is a remarkable similarity between the ore from near the surface and ore from depths of several thousand feet . . . . the same minerals occurring in the same way." The uniformity in the character of the ore leads him to conclude that little change has taken place in the distribution of the copper since the deposits were first formed. Neither does he see, judging by any evidence that is at present available, any reason for believing that the formation of the orebodies has been in any way dependent upon the present surface.

ORIGIN OF COPPER ORES OF THE RED-BEDS TYPE.

In *Economic Geology* for June, Austin F. Rogers, of Stanford University, reaches important conclusions regarding the origin of the copper found so widely in the 'Red Beds' of the Permian. After passing in review the principal occurrences he summarizes substantially as below.

It seems clear from the published descriptions that most, if not all, of the copper ores of the Red Beds type have a similar origin. What applies to one deposit will, with some modification perhaps, probably apply to all. The origin of ores of this type has been discussed by Emmons, Lindgren, Turner, Graton, Schmitz and Hill. Both Turner and Schmitz incline to the syngenetic origin, but Lindgren considers that the epigenetic origin is practically proved. While the geological evidence perhaps favours the epigenetic origin of the copper ores, the microscopic evidence conclusively proves it, for the copper minerals were introduced at a comparatively later stage. Whether these ores were deposited by cold descending meteoric waters or by hot ascending solutions is the next question to be settled. Lindgren sees in these copper ores the work of meteoric waters. As to the Sierra Oscura occurrence, Graton believes that copper-bearing solutions have come up from below along faults. Turner, on the other hand, thinks that the ores are later than the main faults. In the Tularosa (New Mexico) district copper ores occur in sandstone of the 'Red Beds' and also in an underlying igneous rock (diorite-porphyry). Graton, who describes these deposits, believes that these two types of ores are closely related in origin. He dissents from the views of Lindgren and decides in favour of the formation of both the Tularosa and Sierra Oscura copper ores by hot, ascending solutions.

The geological evidence, while perhaps favouring the meteoric origin, is not conclusive. It is, moreover, probable that Lindgren's views are partly based upon the supposed reducing action of the organic matter on copper solutions to form chalcocite. But we know that in the case of the Sierra Oscura and Nacimiento deposits chalcocite was not precipitated by organic matter, and it is not at all certain that such was the case in the Red Gulch deposit. As the copper ores occur in the nodules as well as in the plant replacements at Sierra Oscura, the rôle of carbon as a reducing agent is very improbable. As Lindgren himself has said, "The importance of precipitation by carbonaceous material has been over estimated. . ." In this connection it is interesting to note that Clark failed to precipitate copper sulphide on coal from a solution of copper and ferrous sulphates even at the end of 122 days. Lindgren's remark "It is necessary to explain why chalcocite is characteristic of these deposits and chalcopyrite of the fissure veins" loses its force after the results of the microscopic examination are obtained.

All students of ore deposits must admit that at least some types of ore deposits, though perhaps greatly in the minority, are formed from meteoric waters, though, as Lindgren says, "The prevailing influence of igneous intrusions on ore deposition is, however, so strong that it is difficult to establish the proofs of the less conspicuous deposition by purely meteoric water."

It is well to consider the evidence furnished by the microscope, for it is in cases of this kind, when the geological evidence is not convincing, or when the geology admits of several interpretations that we may turn to the microscope with some degree of confidence. The history of an ore deposit is written in the mineralogical changes revealed by the microscope, as well as in the broad geological features, and when we have made a little more progress, interpretations based upon microscopic work will probably be more exact than those based upon field geology, though of course microscopic work and field work should go hand in hand.

The later stages of the Sierra Oscura ores are clearly the result of meteoric waters. The replacement of bornite by chalcocite does not in any way suggest the irregular "upward enrichment" structure recently described here. The fact that bornite is bordered by chalcocite and penetrated by veinlets of chalcocite is clear evidence of descending solutions. As the chalcocite immediately preceded the melaconite stage it is certainly formed by solutions directly in advance of the oxidizing solutions and these must have been meteoric waters. The chalcocite, then, is certainly the product of downward enrichment.

Next may be considered the earlier stages. Of the earlier formed minerals hematite furnishes the most conclusive evidence as to the origin of the Sierra Oscura ores. There are two fairly well defined kinds of hematite. The well crystallized hematite (specularite) is a high temperature mineral occurring in igneous rocks as a magmatic mineral, in contacts, in deep veins and in volcanic rocks as a sublimate. Cryptocrystalline and amorphous hematite occurs in sedimentary iron ores such as the Clinton ore, in concretions, in pseudomorphs after other iron minerals, and in the gossans of ore deposits of arid regions. The hematite of the Sierra Oscura specimens belongs to the second kind of hematite. Though probably cryptocrystalline by slow, long continued crystallization, there is no indication of the crystalline condition, and it does not have the appearance of specular hematite. Under arid conditions, and we know that at the time of the deposition of the Red Beds arid conditions prevailed in the southwest, hematite was probably formed instead of limonite on account of the presence of salts in solutions or limonite or siderite might have been converted into hematite under these conditions.

Pyrite, while usually formed by ascending thermal waters, is at times undoubtedly formed from meteoric waters. It is fairly common in sedimentary rocks and sedimentary pyrite deposits are known. A large pyrite deposit at Leona Heights, in Alameda county, California, has been assigned a meteoric origin by Whitman, and while his arguments are not convincing for the meteoric origin of this particular deposit, his experiment to produce pyrite under vadose conditions was successful. Siebenthal has observed pyrite in springs at Sulphur Springs, Ark., which has undoubtedly formed from cold alkaline solutions.

Bornite, like pyrite, has usually been formed by ascending thermal solutions, but it, like pyrite and chalcopyrite, is probably a persistent mineral ranging in occurrence from igneous rocks to deposits formed near the surface from cold meteoric waters. Bornite has been described by Mennell as nodules in shales from Mashonaland, southern Rhodesia. It is interesting to note that he believes that the bornite is a replacement of pyrite. While this bornite occurs in Silurian or Lower Devonian sandstone instead of in Red Beds, it is suggestive that the shales show pseudomorphs after cubic crystals of salt.

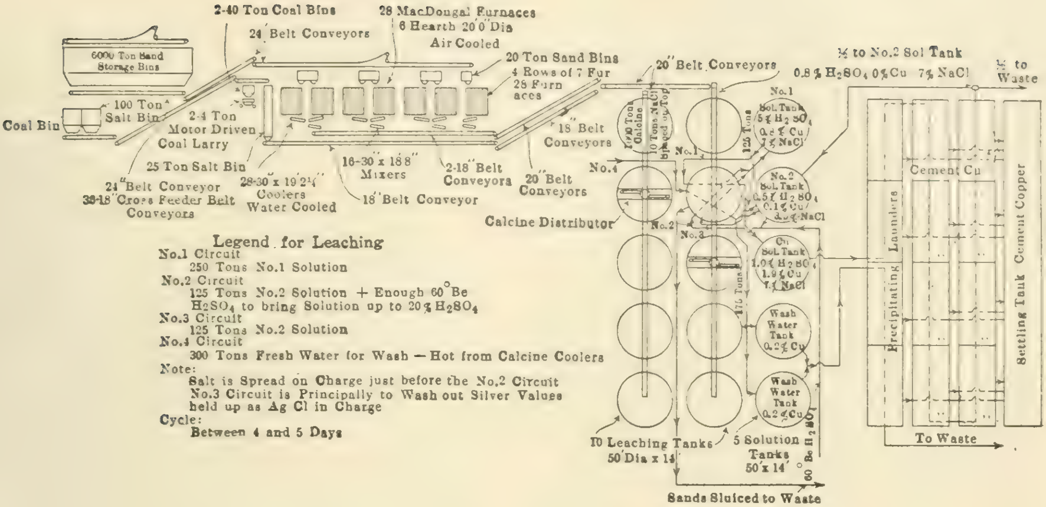
The relation of the bornite to the pyrite is practically that of the 'exploding bomb' structure described by Graton and Murdock, but this structure is probably produced by both hypogene and supergene solutions.

While pyrite and bornite may have been formed either by meteoric or thermal waters, the occurrence of hematite of the low-temperature type in concretions constitutes the most conclusive single argument in favour of the meteoric origin of the Sierra Oscura ores. The presence of hematite in two generations between which periods the sulphides were formed, suggests arid climate followed by humid climate, and finally, by another period of arid climate. The dependence upon the climate is additional evidence in favour of the meteoric origin.

In conclusion, then, it may be said that the microscopic evidence, and the geological evidence as far as it goes, suggest that the copper ores of the Red Beds type were formed by meteoric waters without the agency of igneous rocks. The ores were formed by circulating solutions, which may have been locally ascending, during a long continued period of time. The solutions were alkaline, at least during the earlier stages. As with most ores, there were definite stages of mineralization. In view of the fact that the prevailing trend in the study of ores is towards the increasing importance of magmatic waters (and the writer is fully in accord with this view), it is interesting to find evidence of the influence of meteoric waters in the deposition of ores and to find an application of the theoretical principles of ore-deposition so ably set forth by Van Hise. The Red Beds type of copper ores is probably one of the few cases in which Van Hise's principles of ore deposition will apply.

LEACHING COPPER ORES AT ANACONDA.

As has been recorded in our columns on several occasions, it was intended to treat the sandy tailing at Anaconda by roasting and leaching, and experiments with this object in view were commenced in 1912. The results obtained were so favourable that the construction of a plant having a capacity of 2000 tons per day was commenced. In the meantime the advantages of the flotation process for the treatment of copper tailing was recognized, and it was then decided to adopt flotation for current tailing, and to use the leaching plant for accumulated tailing. The fact that part of the copper in the old dumps is in oxidized form turned the balance of arguments in favour of leaching. The August *Bulletin* of the American Institute of Mining Engineers contains a paper by Frederick Laist and H. W. Aldrich, describing the leaching plant. This plant was started in May 1915, and a flow-sheet is given herewith. The average of the material now being treated is 0·573% copper, and 0·487 oz. silver per ton. The tailing is sent to bins having a storage capacity of 6000 tons. This gives between two and three days' supply for the leaching plant, in case of railroad troubles or difficulties due to cold weather. The bins are of substantial wood construction and are enclosed, the walls and roof of the building consisting of wood sheathing covered with corrugated iron. The bins are arranged in a double row and are hopper-bottomed. The tailing is distributed over the bins by means of a 36 in. belt and movable tripper. Underneath are 36 gates, each with its hopper, from which an 18 in. belt feeder delivers to a 24 in. belt running the full length of the building in the centre. By means of enclosed belts, the ore is delivered from the bins to the top of the furnace building. There are also small coal and salt storage bins from which a belt system conveys the coal and salt to bins in



FLOW-SHEET OF THE LEACHING PLANT AT ANACONDA.

the roaster building. The roasting-furnace building is 232 by 110 ft., and is of steel and concrete construction. There are 28 McDougall-type, six-hearth furnaces arranged in four rows of seven each. The furnaces are 20 ft. in diameter, each being equipped with two fireboxes, diametrically opposite, the flame entering over a fire-bridge directly into the third hearth, the top hearth being designated as the first. The grate dimensions of each firebox are 3 by 4 ft. Each furnace has a 20 ton feed hopper, to which the tailing is delivered by means of two 24 in. belts each equipped with a movable tripper. The furnaces are fed by 14 in. belt feeders drawing from these hoppers, the amount of feed being controlled by gates which are operated by means of a screw adjustment, the feed dropping through a hole in the top arch, directly on to the top floor. During the time the feed is on the two upper floors, it is dried and heated; as it drops to the third or fired floor, the sulphur ignites. The three lower floors are kept hot by the combustion of the sulphur in the tailing. Four flues run the length of the building, one over each row of seven furnaces. Each furnace has two opposite connections, from the top hearth to the flue. All four flues lead into a balloon flue with a downtake of 45°. The balloon flue enters the 15 by 200 ft. steel stack with a 45° uptake. The stack is unlined. In the bottom of the balloon flue is a 6 in. screw conveyor which delivers the flue dust to the belt-conveyor system that receives the roasted ore from the furnaces. The furnaces are air-cooled, the air being furnished by four No. 11 Buffalo blowers each direct-connected to a 50 h.p. motor. The air intake is at the top of the furnace shaft and the discharge at the bottom. The hot air does not enter the furnaces, but is delivered to the leaching and solution buildings for heating purposes by a suitable piping system. When it is not needed for this it is discharged into the atmosphere. Each furnace is equipped with a cylindrical cooler, 30 in. in diameter and 19 ft. long. The roasted ore after being cooled enters a mixer or concrete-lined steel cylinder, at the head end of which a very small stream of water is added to settle the dust. The mixer discharges a moist warm material to an 18 in. conveyor belt, and by a system of conveyors this is delivered to the leaching building.

The tailing is subjected to a simple oxidizing roast, no particular care being taken to obtain a large amount of sulphate. The sulphur content of the feed is about 2·2% and that of the discharge about 0·6%. One-third of the total sulphur in the discharge is in the form of sulphate. When too hot a roast is attempted in order to decrease the total sulphur content, a certain portion of the copper is rendered insoluble in all ordinary acids, with the exception of hydrofluoric. A pyrometer is inserted over the fourth floor of every furnace, and by means of these, the firemen are able to keep constant control of the temperature. The best results are obtained by keeping the fourth floor at about 500°C. The hottest hearth in the furnace is the third or fired floor, and averages about 535°C. The water for the cooling system enters at about 40°C., is discharged at 65°C., and is piped to the solution building, where it is used to heat the circulating solutions. It is then pumped back and used again in the coolers. The material after passing through the coolers, and after the addition of 1% moisture, while going through the mixers, has a temperature of about 45°C. During the conveying from the roasters to the leaching tanks, this temperature is lowered to 40°C.

The leaching building is 293 by 122 ft, and is of steel and wood construction. It contains 10 redwood vats, each 50 ft. in diameter and 14 ft. deep. The average charge to a vat is about 1000 tons. The vats are equipped with an ordinary filter bottom, made of 1¼ in. slats resting on 2 by 4 in. spaces. Above this are two layers of heavy cocoa matting, and on top of the matting is a grating, made of 1¾ by 3½ in. material, with 6 in. square pieces. The grating fills with roasted material 3½ in. deep and serves to keep the force of the sluicing water from tearing the matting. The acid solutions rot the matting, but if not disturbed, it will hold its shape and be an efficient filtering medium long after it is too much decomposed to handle. All the vat hoops are covered with lead pipes to protect them against leaks of acid solutions. The vats are in two rows of five each. A 20 in. conveyor belt travels over each row, and by means of a tripper, the material is dumped into a suitable distributor, which spreads it over the vat. Each vat has three lead pipes 4 in. in diameter and one 4 in. iron pipe entering at the top.

The lead connections are for strong and dilute acid solutions and the iron pipe is for wash water. Above the level of the leaching vats an iron storage tank is provided for holding the stock of concentrated acid, Its capacity is about 120 tons of 60°Bé. acid. All concentrated acid, used to raise the acid strength of any solution, is added to the solution as it goes on the charge in the leaching tanks. There are seven 10 in. sluicing gates in the bottom of each leaching vat, one in the centre and six spaced equidistant from each other in a circle about half-way between the centre and the circumference of the vat. These discharge into launders which connect with the main tailing launder. 'Acimet' valves and lead piping are used throughout for handling dilute and concentrated acid solutions. The floors of both the leaching and solution buildings are of concrete, and are painted with an asphalt-tar mixture for acid proofing. These floors slope to a gutter which connects to a pump sump and in this way any overflow or leakage of solution is saved and returned to the system. The solution-tank building is a lean-to off the leaching building and contains five solution-storage tanks. These are 50 ft. in diameter and 14 ft. deep. Solutions drain from the leaching vats to the storage tanks, and are pumped to the top of the leaching vats, from the solution tanks, by means of vertical-shaft, direct-connected, hard-lead, centrifugal pumps.

The leaching is done by continuous downward percolation, no circulation or upward percolation being used. The percolation rate will vary from 3 in. per hour with the first solution to as high as 10 in. per hour with the wash water. As nearly as possible, all solutions and wash waters go on the charge at 40° to 50°C. It requires about one-fourth of the weight of roasted material, in weight of solution, to saturate a charge thoroughly.

There are five solution tanks: One for storage of No. 1 solution, one for No. 2 solution, one for copper solution, and two for wash-water.

	Cu. Per Cent.	H_2SO_4 Per Cent.	NaCl Per Cent.
No. 1 solution tank	0·8	5·0	7·0
No. 2 solution tank	0·1	0·5	3·5
Copper-solution tank	1·9	1·0	7·0
Wash-water tanks	0·2	1·0	1·0

After a tank is charged, 250 tons of No. 1 solution is added as fast as the charge will absorb it. The drain valve is always open, so, as soon as the solution reaches the bottom of the tank, it commences to drain to the copper-solution storage tank as copper solution. From the copper-solution tank there is only one outlet, which is to the precipitation launders. After travelling through the launders, two-thirds of the solution is returned to the No. 2 solution tank and the balance wasted. This waste is necessary to keep impurities such as iron and aluminium sulphates from accumulating in the system. When the No. 1 solution has all been added to the leaching vat, the solution is allowed to drain until none shows on the top of the charge, when 1% of the weight of the charge of common salt (NaCl), is spread over the charge. On top of the salt is then added 100 tons of solution from No. 2 solution tank, but with additional strong acid to bring it to 20% H_2SO_4. Following the 20% acid solution, 150 tons of No. 2 solution is added, but without additional strong H_2SO_4. This scheme gives a zone 4 or 5 ft. in depth of very strong chloridizing solution, travelling down through the charge. There is about 8% of ferrous and ferric iron in solution, which, with the salt, forms ferric chloride, in itself a very corrosive reagent, even dissolving a considerable amount of unroasted sulphide. This chloridizing action also extracts the silver, and without it very little silver is recovered. The 150 tons of No. 2 solution which follows the 20% acid is for the purpose of washing out silver chloride and dissolved copper which may have been held in the charge. It carries very little copper or acid, but is fairly high in salt content, and therefore better than a clean water wash. Following the last acid solution, about 300 tons of hot, clean water is added. The two portions of No. 2 solution, one at 20% acid, and the other at 0·5% acid, after percolating through the charge, drain to the No. 1 solution tank. The wash-water, less a quantity sufficient to make up for the discarded solution, drains to the two wash-water tanks. The balance goes to the No. 2 solution tank and adds enough to make up the amount of solution discarded from the precipitating division each day.

The precipitation of the copper and silver is effected by means of scrap iron. The precipitating launders are of concrete, each about 250 ft. long, and having a section of 4 by 8 ft. available for containing iron. Each launder is partitioned into four sections by concrete walls. Any of the 12 sections may be by-passed for the purpose of cleaning-up. In the bottom of the launders is a heavy wood grating, upon which the iron rests, leaving a space about 6 in. under it, for accumulation of any cement copper which may drop off the iron. In the side of each section, at the bottom, are four 6 in. holes, toward which the concrete bottom slopes. These holes discharge into launders which carry the copper to a settling tank. There it is washed and stored, and finally excavated with a clamshell bucket, and at present sent to the briquetting plant before blast-furnace treatment.

The practice is too old to necessitate much explanation. The main advantages in the practice at this plant over the usual practice are the large launders, which make it possible to put in large and odd-shaped pieces of iron, and the presence of salt in the solutions which prevents the copper from plating on the iron, and makes a soft spongy cement copper which is easily washed off with a hose, leaving the iron clean for more precipitation. It is never necessary to remove the iron for cleaning. The silver is recovered by precipitation on the precipitated copper.

The resulting cement copper carries about 70% copper. The following data are taken from the reports for the month of October, 1915. This is a representative month, but it is certain that the results will be improved upon, after longer operation.

RESULTS DURING OCTBER, 1915.

Sand tailing treated, tons	70,401
Copper in feed, per cent	0·575
Silver in feed, ounces per ton	0·45
Copper in tailing, per cent	0·082
Silver in tailing, ounces per ton	0·14
Sulphuric acid (60°Bé.), pounds per ton of feed	64·90
Coal, per cent. of feed	3·30
Salt, per cent. of feed	1·52
Iron, pounds per pound of copper	2·00

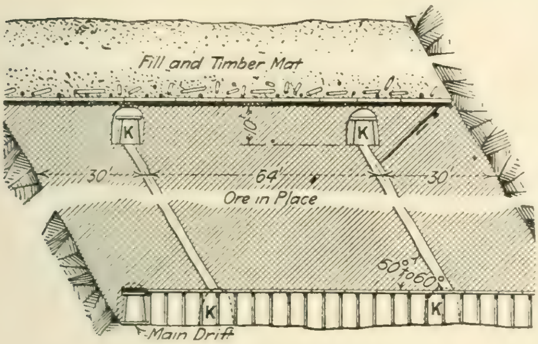
The plant during this month made an extraction of about 80% of the copper and 60% of the silver. This is less than indicated by assays of heads and tailings owing to various plant losses, of which the largest is dust from the roasting furnaces amounting to about 4·5% of the copper in the feed.

ANALYSES OF FEED AND TAILING.

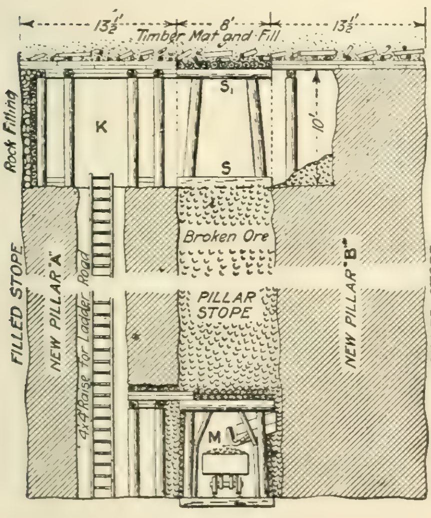
	Cu %	Ag Oz.	SiO_2 %	FeO %	S %	Al_2O_3 %	CaO %
Feed	0·575	0·45	81·3	3·0	2·1	9·4	0·4
Tailing	0·082	0·14	84·7	2·4	0·4	8·7	0·4

RECOVERING ORES FROM PILLARS.

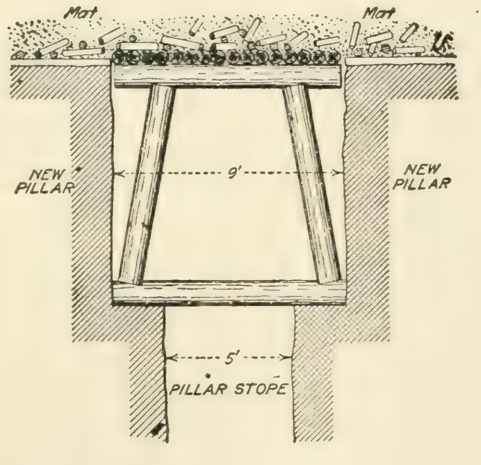
In the *Engineering and Mining Journal* for July 29, H. H. Hodgkinson describes the method of extracting the ore at the mine of the New Jersey Zinc Company, at Franklin, New Jersey. This method was devised by R. M. Catlin, and developed by the author. It is a combination of two old systems; first, extracting ore by shrinkage stoping and filling the stopes with waste, and second, attacking the pillars left behind by an intermediate shrinkage stope and top-slicing. The accompanying illustrations show the system adopted in the second part of the operations, that is to say the recovery of the ore from the pillars. The pillars are about 35 ft. wide, and they extend from foot to hanging wall, say 120 ft., having a vertical height of about 50 ft. The policy is to form an internal pillar stope, down which the ore removed by top-slicing can be discharged. Approximately a quarter of the ore is won by shrinkage stoping in this internal pillar stope, and three-quarters by top-slicing. A cross-cut *M* is first driven through the pillar across the lode. This is 10 ft. high and 8 ft. wide, and 13½ ft. of ore is left on each side. Two rises, 4 by 4 ft., are put up at an inclination of 50 to 60° from two short drifts within the 13½ ft. pillars. Cross-cuts 5 by 5 ft. *K* are driven from the rises at 10 ft. intervals toward the internal shrinkage stope to provide entrance to the stope over the broken ore. When the broken ore rises to their level, they are bratticed off. The two rises *C* and *D* when finished are equipped with ladders and air-pipes. Shrinkage stoping is commenced from *M* and carried up to the top of the pillar. Then the broken ore is lowered below the level of the first slice, and the sill timbers *S* are placed in position. Top-slicing then commences in the usual way, and the broken ore is delivered to the shrinkage stope. It will be seen that by this method there is little likelihood of the pillars crushing, for they are supported by the waste filling of the old stopes and by the broken ore in the internal stope. Moreover there is much less handling of broken ore than in the ordinary top-slicing of pillars without the internal stope. The only disadvantages appear to be the cost and time of cutting the hitches for the sills and the occasional breaking of the sills. These could be obviated by making the internal stope 5 ft. wide and by resting the ends of the sills on the bottoms of an enlarged part at each successive slice.



Section across Lode.



Section across Pillar.



Proposed Variation in Arrangement of Sills.

Floating Oxidized Ores. — Ever since the principle of concentration by flotation was established, many metallurgists have sought to make carbonates and other oxidized ores amenable to the treatment, by forming a sulphide or metallic coating on the particles of ores. Investigations have been made by O. C. Ralston and Glenn L. Allen for the United States Bureau of Mines, and their preliminary report has been published. This is reprinted in the *Mining and Scientific Press* for July 29. Their work has been devoted so far chiefly to lead ores, and more study is to be given later to copper ores. As far as is seen at present, zinc ores do not appear to respond to the treatment.

The methods of sulphidizing that have been investigated are: (1) By the use of hydrogen sulphide on either the dry or the wet crushed ore, (2) by the use of solutions of the various sulphides and sulpho-compounds of sodium, (3) by the use of solutions of the various sulphides and sulpho-compounds of calcium, (4) by the use of sulphur vapour, (5) by the use of sulphuretted oil, (6) with colloidal sulphur. It has been found that treatment by some of these methods will form a film of sulphide over the surface of the particles of such minerals as lead carbonate or copper carbonate, whereas in other cases the mineral particles are sulphidized to the core. In general, a high alumina content (acid soluble) in an ore seems to prevent the application of sulphidizing to flotation.

In sulphidizing with hydrogen sulphide gas, as applied to the lead-carbonate ores, it was found that the best method of applying the gas to a dry powdered ore was in a tumbling barrel with the gas inlet in the end. Sulphidizing in a glass bottle showed that the ore blackened quickly after the application of the gas. On attempting to float lead sulphide from the ore as soon as it had blackened, it was found that a low extraction of lead was obtained and likewise a low-grade concentrate, unless the pulp was previously acidified with sulphuric acid. By acidifying the pulp, a cleaner concentrate was floated, but the extraction of lead remained low. Only by prolonged treatment with gas could the extraction of the lead be raised to commercial grade. With a number of ores eight hours' treatment gave an extraction of over 80% of the lead.

The use of hydrogen sulphide was considered for the reason that it can be generated cheaply. With iron matte available at $5 to $10 per ton, and sulphuric acid at from $5 to $10 per ton, the cost of the hydrogen sulphide resulting, including labour, etc., is between $30 and $50 per ton. If this gas in combining with the metal in the ore produces only a surficial film of sulphide, and does not penetrate to the centre of the particles, it might be possible to make a ton of the gas sulphidize many tons of ore. Unfortunately hydrogen sulphide attacks the metallic particles of the ore with such avidity that by the time the latter are sulphidized sufficiently to permit of good extraction by flotation, they have been sulphidized to the core, and practically a chemical equivalent of hydrogen sulphide to the total lead has been absorbed. Even coarse pieces of ore in a bottle absorb the gas with evolution of heat, and on breaking open the pieces the black colouration is seen to have travelled deeply into the particles. Owing to the fact that the value of the lead concentrate obtained is very low as compared to the amount of hydrogen sulphide necessary to sulphidize it, this process is not regarded as commercially practicable.

Application of hydrogen sulphide to the ground ores suspended in water does not seem to be subject to the same difficulty. True filming of the particles with lead sulphide seems to take place, and the extractions possible after a short treatment with the gas are satisfactory. The speed of travel of molecules of gas, as compared with the speed of travel of the same molecules in solution affords an explanation of the difference in the action of the gas when applied to dry pulverized ore as compared with its action when applied to pulp suspended with water.

The best results on lead-carbonate ores have been obtained when sulphides of sodium were used for the sulphidizing agent. The sodium sulphide must necessarily be introduced in solution and seems to cause true filming. The sulphides of sodium considered commercially applicable are the normal sulphide of sodium, Na_2S; sodium poly-sulphides, Na_2S_4, and Na_2S_5, and the sulph-hydrate of sodium, NaSH. Of these, the last, the sulph-hydrate, seems to be effective, as is evidenced by the quicker blackening of the pulp, and the deeper blacker colour formed. The normal sulphide is almost as effective; the poly-sulphides seem to be the least active. Different ores require 10 minutes to 24 hours of contact with the solutions of sodium sulphide, depending on the properties of the ore and on the strength of the solution. Amounts of sodium sulphide varying from 10 to 20 lb. per ton of ore are usually sufficient, and should be applied to pulp containing about one ton of water per ton of ore, in order that the solution may be as strong as possible during the sulphidizing stage of the process. After a good black colour has developed and the colour has ceased to increase in blackness, the pulp is diluted with water to a 3 : 1 or 4 : 1 mixture and floated in either mechanically agitated or pneumatic machines. The market for sodium sulphide is limited and it should be obtainable at considerably less than 2 cents per pound.

The poly-sulphide of calcium, obtained by boiling powdered sulphur with slaked lime, seems to be satisfactory for ores that yield easily to sulphidizing, but is sluggish in its action as compared with the sulphides of sodium. The normal sulphide of calcium is only slightly soluble and hence its use was discontinued as a possible sulphidizing agent. The sulph-hydrate of calcium is the most active of these reagents, but has not been tested to any extent in this work, as there is doubt as to whether it would be commercially feasible to prepare such a compound.

Sulphidizing with sulphur vapour has been tried with little success, for the reason that it must be applied at a temperature above the boiling-point of sulphur in order to prevent condensation of the sulphur. This means that the ore must be heated to a temperature above 445°C. There seems to be no difficulty in obtaining elemental sulphur vapour commercially, as pyrite will give up half of its sulphur content when heated in a closed space, and sulphur dioxide gas can be reduced to elemental sulphur by passing it through a heated zone in the presence of a reducing agent. As lead itself is easily reduced from its carbonate form, the temperature might as well be raised to the point where the lead can be liquated out, a reducing atmosphere being used instead of a sulphidizing atmosphere.

The use of a sulphuretted flotation oil, in which loosely combined sulphur is available for combination with carbonates of lead or other metals, and the rest of the oil is then available for oiling the artificial sulphide, has given little encouragement in the tests conducted by the Bureau. Finally, colloidal sulphur, mentioned as a possible method of sulphidizing, does not seem to combine with lead carbonate at all. It floats as a white lining of the air bubbles in the flotation machine, and brings up very little lead with it.

Usually the precious metals contained in a lead-carbonate ore accompany the lead. The silver extraction will lag behind the lead extraction when the ore is sulphidized with sodium sulphide, and the reverse has usually been true when hydrogen sulphide was used.

A flotation plant to apply sulphidizing and flotation to an ore containing lead, silver, and gold is being constructed by the Prince Consolidated Mining Co., at Pioche, Nevada, for the treatment of two tailing-dumps from former pan-amalgamation and cyanide operations in that vicinity. This plant is expected to be in operation shortly.

Many attempts have been made, both by large operating companies and by other experimenters, to float the carbonate and other oxidized minerals of copper.

Hydrogen sulphide seems to be by far the best

ELECTRICAL WINDING PLANTS ON THE RAND.

	Type of winder	No. of winder motors	H.P. of winder motors (continuous rating)	Maximum depth of wind	Weight of rock per wind	No. of complete trips per hour	Voltage of winder motors	Speed of winder motors R p.m.
Crown Mines	Ward-Leonard Cylindro-conical drums	2	2000 each motor	3540 ft. vertical	8 tons	44	1000 across 2 motors in series	53·5
Crown Mines	2 Ward-Leonard. Cylindro-conical drums	4 (2 on each winder)	1420 each motor	2260 ft. vertical	8 tons	45	1000 across 2 motors in series	53·5
E.R.P.M. Hercules Shaft	Ward-Leonard. Cylindro-conical drums	2	754 each motor	4500 ft. vertical	8 tons	20	1000 across 2 motors in series	33·3
Village Deep and City Deep (6 similar equipments)	3-phase motors direct-coupled (2 cylindrical drum hoists 4 Whiting hoists)	1	1600	3600 ft. vertical	5 tons	32	2000 volts 3-phase, 50 cycles per second	100
Bantjes	3-phase motor, geared to cylindrical drums	1	1470	4000 ft. incline	5 tons	23	2000 volts, 3-phase, 50 cycles per second	250
Consolidated Langlaagte (2 similar equipments)	Ward-Leonard	1	1290	Compound shaft 1230 ft. vertical and bend. 3000 ft. incline	5 tons	23	500 direct current across winding motor	80
New Modderfontein	3-phase motor direct-coupled to cylindrical drums	1	1200	2000 ft.	3 tons	45	2000 volts, 3-phase, 50 cycles per second	

medium for sulphidizing oxidized copper ores previous to flotation. When applied to the dry ores the same conditions were found as those mentioned for lead; the particles are sulphidized to the centre, which requires an excessive amount of hydrogen sulphide. Applied to the wet pulp, the hydrogen sulphide seems to cause true filming. Messrs. Ralston and Allen's work yielded a black concentrate, but they were informed by J. M. Callow that he has been able to reduce the amount of sulphur used to a point where the froth is green with slightly coated malachite. He stated that as little as half a pound of sulphur per ton of ore is giving good extractions in the plant of the Magma Copper Co., at Magma, Arizona, where his company has put in the first successful installation of this kind.

Sodium sulphide has been tested by a number of the larger companies that have oxidized copper minerals in their sulphide ores. The amount of oxidized copper in such ores is usually a fraction of 1%, so that only two or three pounds of sodium sulphide per ton of ore is necessary. This is usually added to the machines during flotation, or to the mixing-tanks before flotation. The authors' experience is that if some little time of preliminary contact is allowed before flotation is attempted, better sulphidizing of the material will result.

Calcium poly-sulphide has been used for some time in a number of the large copper-concentrating mills with indifferent success, and seems to be detrimental in some instances. On the ores tested by the authors fair results were obtained if the calcium poly-sulphide was allowed to act until the ore had become well blackened.

It is stated that sulphur vapour was tested at one of the large plants for flotation of oxidized forms of copper and gave better results than any other method of sulphidizing. This method has the disadvantage of having to be applied to dried, heated, and finely divided ore. Sulphuretted oils are being used at a number of plants to supplement other methods of sulphidizing and considerable secrecy is observed as to the technical details of this work. Colloidal sulphur does not assist in the flotation of oxidized forms of copper. Neither has the silicate of copper been successfully floated by sulphidizing flotation. It will blacken when sulphidized, but resists flotation. Possibly it still presents a silicate, rather than a sulphide, surface to the flotation elements. For this reason a number of the large copper companies are seriously contemplating leaching the oxidized copper ores, rather than lose what silicate of copper may be present. Repeated attempts to float the natural sulphides along with sulphidized minerals have failed, as the sulphidizing agents cause trouble with the flotation of the natural sulphides. By careful adjustment this difficulty has been solved in one plant, though the details are not available.

Electrical Winding on the Rand.—The *South African Mining Journal* for June 3 publishes a table giving particulars of the largest electrically driven winding engines on the Rand. This table was prepared by the South African Institute of Electrical Engineers. We reproduce the greater part of this table at the top of this page.

The Marathon Mill.—This fine-grinder has attracted attention in America during the last year or two but reliable details of its performance have hitherto been lacking. This machine is made by the Johnson Engineering Works, Chicago, and installations have been erected at copper mines in Arizona, lead mines in Idaho, and at other places. It may be described as a short tube-mill, iron-lined, and having iron rods arranged longitudinally instead of steel balls or pebbles. The advantage as compared with pebbles or balls is that a crushing line is obtained instead of a series of crushing points, and that much more work is done by a rod than by a row of pebbles or balls. The August *Bulletin* of the American Institute of Mining Engineers contains a paper by F. C. Blickensderfer, describing tests of the mill, conducted by him at the concentration plant of the Detroit Copper Mining Company in Arizona. The practice at this plant was to send the tailing from the Wilfley tables, after removing most of the slime and some of the water, to Chilean mills of the Monadnock type for re-grinding, with sub-

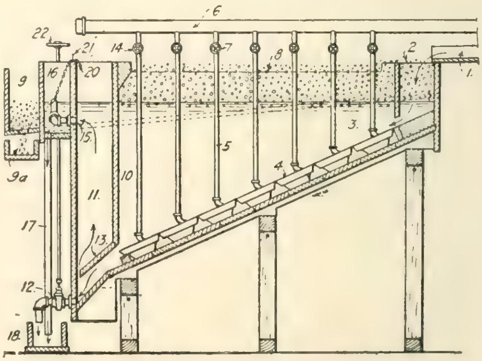
TESTS OF THE MARATHON MILL.

	Running Time in Hours	Running Time per centage of Total Time	Tons Dry Feed per 24 hours	Tons Pulp per 24 Hours	Percent-age of Solids in Pulp	Ratio of Solids to Water	Gallons of Water per Ton of Feed	Gallons of Water per 24 Hours	Horse-Power	Tons Dry Feed per Horse Power per Day	Revolu-tions per minute
Marathon No. 2	200	94·25	440	693	63·5	1 : 0·57	138	60·720	22·5	19·5	30
Hardinge	1455	96·25	244	570	42·8	1 : 1 3	320	78 226	56·5	4·4	29
Chilean	1041	93 75	237	951	24·9	1 : 3	723	171·540	36·7	6·5	30

Type of Mill	Stationary Grinding Parts					Movable Grinding Parts					Total Grinding Parts
	Kind of Stationary Grinding Surface	Wt. of Stationary Grinding Surface, Pounds	Life of Liners or Die, Days	Liners or Die Consumed in 24 Hr., Lb	Liners or Die per Ton, Pounds	Charge Used in Mill	Wt. of Initial Charge, Pounds	Total Pounds Added During Test	Pounds Consumed in 24 Hr.	Consumed per Ton of Feed, Pounds	Consumed per Ton of Feed, Pounds.
No. 2	Iron Plates	4,480	72	62·256	0·14149	Iron Rods	7,124	1,441	172·92	0·39295	0·53544
Hardinge	Pebbies	6,740	159	41·761	0·17115	Pebbles	10,175	31,956	527·00	2·16	2·33115
Chilean	Die	1,722	63	27·333	0·11533	3 Tyres	2,526	None	41·66	0·1762	0·29153

sequent treatment on Frue vanners. Each unit, with nominal capacity of 750 tons per day, contained four of these Chilean mills. At the time the test was made, it was desired to try the Hardinge conical mill as well, so two of the Chileans were removed and a Marathon and Hardinge were substituted. The first test of the Marathon mill did not give results of much value, owing to defects. Afterward, some modifications were made in the structure of the mill, with results that may be described as remarkable. In No. 2 test the Marathon was found to do the work of three Chilean mills, and it is also notable that the proportion of water in the pulp was greatly reduced. We give herewith some figures of the results of the second test of the Marathon and of the tests of the Chilean and Hardinge. These figures contain details of the relative capacities of the machines and of the power required, also of the consumption of iron and pebbles. The high capacity and the low power required for driving are outstanding features of the Marathon mill. There are other points of interest worth mentioning. If the machine is overloaded the result is a product that is uniformly coarser, whereas with a Hardinge the result is that the oversize increases. With a Marathon mill, 3 ft. in diameter by 7 ft. in length, the rods used range in diameter from ½ in. to 2 in. When they wear, some of them break up and are discharged. It is well to add more rods every day, and to examine the entire charge every 10 days and remove those that are disabled. The liner plates are made thicker at the ends than in the middle, so that the inner surface is slightly corrugated. This construction prevents undue slipping of the rods. The rods always retain their longitudinal position. The authors state that experiments are in hand for demon strating the value of the machine as a coarse crusher.

Hyde's Pneumatic Flotation Cell.—In the *Mining and Scientific Press* for August 5, James M. Hyde describes a flotation cell, which is a development of that devised by J. M. Callow. We gave particulars of the Callow plant in our issues of August 1914, and January 1916. According to his system, compressed air is forced upward through the false bottom of the cell into the oiled pulp and the froth concentrate is removed over lips. Mr. Hyde introduces detailed improvements in this type of cell. Instead of having one continuous canvas bottom, with partitions underneath, he divides the bottom into segments (*4*), each made of iron with canvas stretched across. In this way the bottom may be more easily repaired and leakage between partitions is avoided. At the discharge end of



LONGITUDINAL SECTION OF HYDE'S FLOTATION CELL.

the cell there is a partition (*10*) which prevents the mineral froth from approaching the points where the slime and water are discharged. Most of the sand tailing is discharged through the valve (*12*) into the launder (*18*). The water and slime rise in the chamber (*11*), and pass through a port (*15*) into a swing pipe in the chamber (*16*), and fall through the pipe (*17*) into the launder (*18*). By regulating the position of the swing pipe and the discharge valve, the water level can be made constant against possible variations in the feed. The chamber (*11*) being free from mineral froth, the operator can always judge the water level in the cell. A deflector (*14*) at the top of the partition (*10*) creates a counter-current toward the feed end of the flotation cell.

TECHNICAL JOURNALS FOR THE MONTH

BRITISH.

Colliery Guardian. — *August 4:* American Car Dumpers for discharging coal or other minerals from cars to ships, etc.; List of Approved Safety Lamps; Shaft-Sinking by Cementation at the Holditch Iron Mine, Staffordshire; The Phœnix Electric Safety Lamp, employed in coal mines in Northern France. *August 11:* Coal Discharging Equipment at the Port of Bordeaux, F. J. Warden-Stevens; South Wales Coal-Dust Experiments; Gas Detector for Miners' Electric Safety Lamps, T. J. Thomas. *August 18:* Electric Winding Plant at the Staindrop Colliery, near Sheffield, on the British Westinghouse system; Explosive Gas in Coal Mines, its Source and Origin, Norton Tompkins; The Constitution of Coal, D. T. Jones and R. V. Wheeler, a paper contributed to the Chemical Society. *August 25:* American Coal Tipples, H. J. Edsall; The Bonecourt Waste-Heat Boiler.

The Engineer.—*August 11:* The Past and Future of Industrial Chemistry [continued August 18, 25]; Coal Wastage. *August 18:* Power Required in Rolling Metals, C. E. Davies; Coolgardie and Kalgoorlie Water Pipe Line, particularly with regard to corrosion; Deep-well Pumping Plant in the City of London. *August 25*: Power with By-product Recovery, T. R. Woollaston.

Engineering.—*August 11:* Lymn-Rambush Gas-Producer, suitable for treating low-grade high-ash fuel. *August 18:* Turbo-Compressor for Colliery Requirements; Platinum, its Production and Applications. *August 25:* Ore Concentration by Flotation; Swedish State Hydro-electric Power Station at Alfkarleby; Overhead Conductors of Aluminium, Zinc, and Iron.

Geological Society of London.—*June:* Tertiary Volcanic Rocks of Mozambique, Arthur Holmes; Geology of the Northern Margin of Dartmoor, F. P. Mennell.

Iron and Coal Trades Review.—*August 4:* Production and Use of Power and its Relation to Fuel Economy—III., G. Stanley Cooper; Methods of Dealing with Mine Water in the Mold Coalfield, North Wales, William Hopwood; Fullerton's Vertical Air-Compressor; Fletcher-Russell's Gas-heated Furnaces. *August 11:* Industrial Diseases of Iron and Steel Workers in Middlesbrough, J. Watkin Edwards; The Stonehouse Scrap-Bundling Machine; Ironstone Mining by Open-cut at the Buckminster Mine of the Holwell Iron Company. *August 18:* The Iron and Steel Industry in British Columbia, James Ashworth; Coal-Dust in Welsh Mines, the stone-dust remedy criticized. *August 25:* Boilers Heated by Coke-Oven Gas; Dealing with Excessive Water from a Vertical Bore-hole at Gordon House Colliery, Durham; Pit-Head Baths at the Mines of the Ocean Coal Co., Treharris, South Wales.

Royal Society of Arts Journal.—*August 4, 11, 18:* Optical Glass, W. Rosenhain.

COLONIAL.

Canadian Mining Institute Bulletin. — *August:* Manufacture of Asbestos Goods in Canada; Canadian Metal Trades and Preparedness; Mine Rescue Work in the Province of Alberta, J. T. Stirling.

Canadian Mining Journal.—*July 15:* Progress in Underground Ore-Loading, M. E. Richards. *August 1:* The Manigotagan Gold District, Manitoba, J. S. De Lury; Concentrating Cobalt Silver Ores by Flotation, Ben Hughes; J. W. Boyle, the Dredge King of the Klondike, F. G. Carpenter; From Lake Athabaska to Great Slave Lake, Charles Camsell.

Chemical, Metallurgical, and Mining Society of South Africa Journal.—*June:* First Aid Work at the Crown Mines, A. J. Brett. *July:* The Valuation of Mines, R. A. Lehfeldt.

South African Mining Journal.—*July 15:* Kameelfontein Diamond Diggings, near Pretoria, P. A. Wagner. *July 22:* Economic Resources of German East Africa, F. A. G. Pape.

Queensland Government Mining Journal.—*June:* The Comet and Sundown Tin and Copper Mines, Ballandean, J. H. Reid; The Maxwellton Goldfield, L. C. Ball; Mica Occurrences in Northern Queensland, B. Dunstan.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*August:* Certain Features of the New Copper-Smelting Plants in Arizona, A. G. McGregor; Leaching Plant at Anaconda, F. Laist and H.W. Aldrich; Mining and Milling Practice at Santa Gertrudis, Hugh Rose; Comparative Tests of the Marathon, Chilean, and Hardinge Mills, F. C. Blickensderfer; Iron Pyrite Deposits in Southeastern Ontario, P. E. Hopkins; Method of Mining Talc, F. R. Hewitt; Miscellaneous Wood Oils for Flotation, R. C. Palmer, G. L. Allen, and O. C. Ralston; An Explanation of the Flotation Process, A. F. Taggart and F. E. Beach.

Economic Geology.—*June:* Conservation of the Oil and Gas Resources of the Americas—II., Ralph Arnold; Observations on the Geology of the Broken Hill Lode, New South Wales, E. S. Moore; Laboratory Studies on Secondary Sulphide Ore Enrichment, S. W. Young and N. P. Moore; Origin of Copper Ores of the Red-Beds Type, Austin F. Rogers; A Type of Ore from the Tyee Copper Deposit, Vancouver Island, V. Dolmage; Crystallographic Intergrowths in Copper-Nickel Ores of Insizwa Range, South Africa, W. H. Goodchild.

Engineering Magazine. — *August:* Economies of Belt Conveyors, R. Trautschold.

Engineering and Mining Journal.—*July 29:* The Gold Mines of Brazil, B. Le Roy Miller and J. T. Singewald; The Engle Furnace for Re-distilling Spelter, R. H. Engle; Mining Ore from Pillars at New Jersey Zinc Co.'s Mine, H. H. Hodgkinson; Test-Pit Sampling of Placers, Harley E. Hooper; Sonoma Magnesite Mines, California, L. H. Eddy; United Eastern Mine, Oatman, Arizona, J. A. Burgess. *August 5*: The Chemical Constitution of Certain Minerals, Joseph E. Pogue; Sampling Placer-Gravel Deposits, Irving Herr; Argonaut Mine, California, L. H. Eddy. *August 12:* Exploitation of Chilean Mines, B. Le Roy Miller and J. T. Singewald; Exploitation of Arkansas Zinc, L. L. Wittich; Concrete Lining for a Water Tunnel at Chicago, H. W. Clausen; Determination of Copper in Low-Grade Ores, F. O. Hawley; Estimating Metallic Aluminium in Aluminium Dust, J. E. Clennell. *August 19:* New All-Steel Gold Dredge at Yuba, California, L. H. Eddy; Notes on Mine Surveying in Flat Deposits, W. F. Boericke.

Franklin Institute Journal.—*August:* Electrical Methods of Recording Gas Flow in Channels and Pipes based on the Linear Hot-Wire Anemometer, L. V. King.

Journal of Geology.—*June:* Linear Force of Growing Crystals, G. F. Becker and A. L. Day; Recording Micrometer for Geometrical Rock Analysis, S. J. Shand; Notes on the Disintegration of Granite in Egypt, D. C. Barton.

Metallurgical and Chemical Engineering.—*July 15:* Catalysis in the Formation of Petrol from Kerosene, G. Egloff and R. J. Moore; Blast-Furnace Irregularities and their Treatment, J. E. Johnson [continued August 1]; Ethyl Alcohol from Wood, F. W. Kressmann; Concentration and Flotation of Lead Ores in Southeast Missouri; Cost Accounting in the Construction and Operation of a Copper Smelter —IV., E. E. Thum. *August 1:* Flotation Experiments, in connection with Suitable Oils, on a Joplin Zinc-Lead Tailing, W. A. Whitaker, G. Belchic, R. Neal, and H. L. Van Velzer; Hygroscopic Properties of Nitrates of Potash, Soda, and Ammonia, Chlorate of Potash, and Fulminate of Mercury, G. B. Taylor and W. C. Cope; Alumina Inclusions in Steel, Albert Sauveur. *August 15:* The Working Efficiency of Rolling Steel, Sidney Cornell; Mechanical Engineering of a Synthetic Phenol Plant, Frederick Pope; Resistivity Measurements of Magnesium, Aluminium, Calcium, and Alloys, E. F. Northrup; Principles of Filtration, D. R. Sperry; Methods of Testing Refractory Fire-Brick, C. E. Nesbitt and M. L. Bell; Powdered Coal for Metal-Heating Furnaces, A. A. Holbeck.

Mining and Engineering World (Chicago).—*June 24:* Mill Equipment of the Engels Copper Mining Co., W. A. Scott; Mining Possibilities in Colombia—III., M. W. Alderson; King Process of Refining Copper; Friction Tests of Two Types of Cars, P. B. Liebermann. *July 1:* Dry Placers at Plomosa, Ariz., W. L. Plummer; Counter-Migration of Pulp and Solution in Cyanidation and Acid Leaching, Bernard Macdonald; Randsburg Tungsten District, J. N. Nevins; Operations of the Magma Copper Co., W. A. Scott; Mining and Metallurgical Progress in the Southwest, S. W. Mudd. *July 8:* Old Dominion Copper Co.'s Operations, W. A. Scott; Relations between Custom Smelters and Small Mine Owners, J. M. Turnbull; Mining Possibilities in Colombia—IV., M. W. Alderson; Chemistry and Metallurgy of Tungsten, M. L. Hartman; Metallurgical Disposal of Flotation Concentrates, R. J. Anderson. *July 15:* Plant Construction of the New Cornelia Copper Co., W. A. Scott; Merits of Oil and Grease Lubrication, W. J. Fouhy; History of the Homestake Mine, Richard Blackstone. *July 22:* Electric Arc Welding, applications in mines and mills, J. A. Seede; Flotation of Oxidized Ores, O. C. Ralston and Glenn L. Allen; Mining Operations at Johnson, Arizona, W. A. Scott; Greenawalt System of Electrolytic Extraction of Copper; The Herman Screening Tube-Mill. *July 29:* North Arkansas Zinc Fields, Thomas Shiras; Commonwealth Mine and Mill, Arizona, W. A. Scott; Philip Deidesheimer, Inventor of the Square-Set. *August 5:* Dividends paid by American Mines during first half of 1916, G. E. Sisley; Reviews of Progress during the half-year at various American mining centres. *August 12:* Nevada Douglas Mines and Mill, Yerington, Nevada, W. A. Scott; Mining Possibilities in Colombia–V., M. W. Alderson; Spelter, its Grade and Uses, G. S. Stone.

Mining and Scientific Press.—*July 22:* Apex Decision in the Jim Butler-West End Case, Tonopah; Bolivian Tin Industry, Howland Bancroft; Outcrops and the Prospector, W. H. Storms; Custom Smelters and Small Mines, J. M. Turnbull. *July 29:* An Extra-Lateral Problem, R. M. Searls; The Ketchikan District, Alaska, E. E. Hurja; Principles Underlying Flotation, J. H. Hildebrand; Flotation of Oxidized Ores, O. C. Ralston and Glenn L. Allen. *August 5:* The Oatman Gold District, Arizona, L. A. Palmer; Ore Treatment at the West End, Tonopah, J. A. Carpenter; Improved Pneumatic Flotation Machine, James M. Hyde; The Neill Jig for Gold Gravels, Howard D. Smith; Snake Creek Tunnel for Draining Mines near Salt Lake City; Simple Tests for Potash, W. B. Hicks. *August 12:* The Problem of Efficiency, J. R. Finlay; Magnesite Production and Markets, S. H. Dolbear; The Reopening of Old Mines along the Mother Lode, California—II., T. A. Rickard.

NEW BOOKS AND OTHER PUBLICATIONS

The Political Economy of War, 2nd Edition. By F. W. Hirst, late editor *The Economist*. London and Toronto: J. M. Dent & Son, Ltd. Price 5s. net. For sale at Technical Bookshop of *The Mining Magazine*.

It is not to be supposed that mining engineers confine their reading to purely technical literature, and for this reason we presume our readers will be interested in this carefully prepared onslaught on war in general, even though they disapprove of the author's strong opposition to the present war and its prosecution to a finality. Beginning with a review of the wars of the 17th and 19th centuries, and following with the wars of the period 1793-1815, Mr. Hirst cleverly uses quotations from historical records to support his theory that these wars could have been avoided, and in fact in some cases were unnecessarily forced upon Great Britain by her own government. He points out how the treatment of neutral shippers in this present war has its counterpart in earlier history. The armament firms will not be pleased with the chapter devoted to the part they have taken in stirring up strife. In the older wars, Great Britain, the author argues, secured no material advantage, but on the contrary the growth of peaceful industry was retarded, national debts were doubled and trebled, and misery produced. The author having pointed out the similarity between this present war and previous wars, it follows that the subsequent disaster will be in proportion to its immensely larger scope of activity and demands upon the resources of the country. These conclusions are not reached without a masterly discussion of war finance from every aspect. Mr. Hirst is well qualified to write a serious work of this character, and although his views are strongly opposed by the government and all the press, he has an influential backing, and it cannot be said that he is not voicing the opinion of men of standing in financial and banking circles. It is certainly an important addition to the serious literature covering current events, and is well worth reading and retaining.

Broken Hill Proprietary—The Steel Corporation of Australia. London: *The Mining World*. Price 3d. For sale at the Technical Bookshop of *The Mining Magazine*.

This little pamphlet was prepared by the Editor of the *Mining World* in order to afford reliable information regarding the entry of 'Props' into general industry, to a London public which has long thought of the great Broken Hill company merely as an important zinc-lead producer. In fact, according to the data here given, it is fast developing into an Australian Steel Corporation with a large supply of 68½% ore from a mine originally bought for £200. It is stated that materials can be assembled at its new works at as low a cost as at favoured points in the United States and that indeed inquiries for goods have recently come to it from that country. The Proprietary is certainly fortunate in having a period of high prices and excessive demand such as the present during which to pass through its 'teething period' and there can be little doubt that the new venture enormously strengthens the position of the company. An interesting side light on industrial conditions in Australia is thrown by the number of illustrations of labour-saving machinery in the new plant.

Coal Miners' Pocket Book. New York: McGraw-Hill Book Co. Price 17s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

Probably no engineer's pocket book entirely meets his needs save the one which he gradually builds up for himself in the course of a long career. Most of us, however, need a book long before we have completed our professional work and we are properly grateful therefore for those built up for us by our professional associates. The best of these pocket books are those which have themselves been built up through a series of years and editions, and the one under review falls in this class. The first edition was published in 1890 by the Colliery Engineer Co. and successive ones up to the tenth were sent out by that company or its successor, the International Textbook Co. This the eleventh edition has been prepared by the McGraw-Hill Book Company and the title has been shortened from 'Coal and Metal Miners' Pocketbook' at the same time that the subject matter has been revised to meet the needs of coal miners for whom the book was originally intended. Much new matter has been inserted in the place of that omitted and the whole has been given a thorough revision which has greatly improved the book. The book is almost entirely devoted to American practice and the choice of such foreign material as has been used seems to have been guided by no rule that we can fathom. For example, in the table of analyses of foreign coals, p. 391, one would have anticipated finding those with which the American coal comes into competition now or will if the Americans expand in the foreign market, but we fail to find Cardiff coal, certainly one most widely sold, in the list. In the Japanese list we only recognize the names of Hokkaido mines which we believe rarely export, while the Omuta and Takashima coals which regularly move to the Pacific Coast are missing. The Kaiping coal in China is too one of those that must be considered in any world trade, but no analyses of Chinese coals are presented. However, these are minor matters in view of the many excellencies of the book and we can recommend it heartily, especially to those who wish to get in touch with American coal-mining conditions.

The Transvaal Chamber of Mines. Twenty-Sixth Annual Report, for the year 1915.

The Annual Report of the Chamber of Mines has become one of the standard reference books of the mining profession. The Rand is unusual among gold-mining districts in the combination of rivalry and co-operation among the mining companies. Elsewhere the rule is either for one large company to dominate a district, as does the Homestake in the Northern Black Hills of South Dakota and the Calumet and Hecla in the Michigan copper region, or for there to be such disunion that there is little effective leadership if not actual war among the mines. On the Rand the big groups are still rivals, but they all work together in and through the Chamber of Mines, save the Robinson group which prefers to go it alone though occasionally co-operating. It follows that the report of the Chamber is really a report upon the whole industry, written from the inside. It includes always three features of major interest: (*a*) the chairman's address; (*b*) reports of the various committees; (*c*) tables of statistics. The report for 1915 is not behind any of its predecessors in interest. Mr. W. H. Dawe reviews the work of the first complete year of the war most effectively, bringing into sharp relief the results of the war on the industry and emphasizing his points with a profusion of statistics that will be a mine of wealth to future writers on economics. We have already discussed editorially some of the changes made at Johannesburg by the war and referred to the fine spirit with which the situation has been met. We will not repeat but recommend our readers to take time to read the whole of Mr. Dawe's speech. He shows clearly how the war has increased taxes and all other costs without raising the price of gold, but he also shows an increasing efficiency which if held will mark a permanent gain. Sir Lionel Phillips, in following, foretells a period of higher commodity prices and as to this most observers will agree. It remains to be seen whether, as was true in America following what till the present was the greatest war ever waged, gold will eventually go to a premium and recompense the miner for present losses. However that may prove, the present is an anxious time for gold miners and the work of the Chamber, as shown by the reports of the numerous committees, shows what wide activities are necessary to safeguard the industry. We would like to speak of these committees in detail but space forbids. So too we may merely mention the tables of statistics covering gold production, labour, dividends, and many similar matters. They afford excellent data for much study.

H.F.B.

Journal of the Institute of Metals, Vol. XV. This volume reports the proceedings of the meeting held in March 1916 and contains the address by the president, Dr. G. T. Beilby, the Third Report of the Corrosion Committee, by W. E. Gibbs, R. H. Smith, and G. D. Bengough, and the following papers: The Electrolytic Method of Preventing Corrosion, Elliott Cumberland; Analysis of Aluminium and its Alloys, W. H. Withey; Annealing of Nickel Silver, F. C. Thompson; Some Tin-Aluminium-Copper Alloys, A. A. Read and R. H. Greaves; Electric Furnaces as applied to Non-ferrous Metallurgy, Alfred Stansfield; Transformations in Alloys of Gold with Copper, Kurnakow, Zemczuzny, and Zasedatelev. The volume includes also the usual useful abstracts of papers relating to non-ferrous metals.

Geological Criteria for Determining the Structural Position of Beds.—This paper is published as the May bulletin of the School of Mines and Metallurgy of the University of Missouri and is written by Professors G. H. Cox and C. L. Dake. The shallow-water formations of the Ozarks give excellent opportunities for studying the methods of determining the geological sequence of the various beds and ascertaining their true tops and bottoms.

Geology and Mineral Resources of the Yilgarn Goldfield, Part II. This publication of the Western Australian Geological Survey reviews the gold belt south of Southern Cross, and has been prepared by T. Blatchford, with the assistance of P. A. Farquharson, E. S. Simpson, and A. J. Robertson. Two of the mines in this district were prominently before British shareholders a year or two ago, the Great Victoria and the Mountain Queen, but they did not prove profitable.

YEARLY REPORTS OF MINING COMPANIES

Dolcoath.—The report of the premier tin-mining company of Cornwall for the six months ended June 30 shows that the increase in the price of tin and the improvement in the grade of the ore raised, as compared with the latter half of 1915, combined to raise the revenue substantially, and on the other hand the advance in the cost of materials slightly added to the working expenses. The ore raised was 41,384 tons, as compared with 40,394 tons, and the yield of tin concentrate 576 tons as compared with 508 tons. The yield per ton was 31·21b. as compared with 28·17 lb., and the income per ton was 30s. 1d. as compared with 22s. 7d. The revenue was £62,350 as compared with £45,659, and the price received per ton of tin concentrate was £108. 3s. 1d., as compared with £89. 17s. 6d. The working cost was £51,986 as compared with £48,935 and the royalty paid was £4156 as compared with £3043. The total cost per ton was 27s. 1d. as compared with 25s. 8d. The profit was £6883, out of which £2507 was written off for depreciation, and the balance was carried forward. During the previous half-year a loss of £4990 was incurred, that half-year having been in fact the most unfavourable experienced since the formation of the present limited liability company in 1895. The directors state that the terms offered by the new owners of the royalties, Hamilton Edwards and A. H. Bond, in connection with a contribution to the development expenses, were not acceptable to the board. The lords offered £4000 to be applied to this purpose, repayable in case an important discovery was made, but not otherwise.

Carn Brea & Tincroft.—This company was formed under limited liability in 1900 to acquire tin mines in Cornwall, between Redruth and Camborne, that had been worked on the cost-book system since 1832. In early days large profits were made from rich ore, but during the last twenty years the developments at depth have disclosed little but low-grade ore. When the present company was formed, no funds were provided for reorganizing the mining and metallurgical methods, and the financial results of operations have oscillated between losses and profits. Five years ago some improvements in the methods were effected by the then manager, E. S. King, the funds being provided out of revenue at a time of high tin-prices, but his development work failed to find any ore of higher grade. Two years ago it was decided to suspend operations at Carn Brea. The report for the half-year ended June 30 shows that 28,586 tons of ore was raised, for a yield of 270 tons of tin concentrate, which sold for £28,457. In addition, unspecified amounts of arsenic and wolfram were sold for £6538 and £3790 respectively. The total revenue was £40,395, of which £3691 was profit. The yield of tin concentrate per ton was 21·22 lb. The total receipts per ton were 28s. 3d. and the total cost per ton 25s. 8d.

Grenville United Mines.—This company was formed in 1906 under limited liability law to acquire a tin mine south of Camborne, Cornwall, that had for many years previously been worked on the cost-book system. The mine is very wet, and the pumping charges are considerable, especially now that the cost of coal is so high. Satisfactory profits were made at first, but during the last three years no dividends have been possible owing to a decline in the tin content of the ore mined. The report for the half-year ended June 30 shows that 21,595 tons of ore was raised as compared with 23,088 tons during the previous half-year. The output of tin concentrate was 266 tons, and the yield per ton 27·5 lb., as compared with 296 tons and 28·8 lb. The accounts show an income of £27,944 from the sale of products, and from other sources £1013. The total cost was £32,461, so that a loss of £3566 was incurred. During the previous half-year the loss was £4765. The company has a loan from the bankers of £18,753, secured on the reserve fund of £56,650, which is all in trust investments. Henry Battens, the manager, reports that the developments between the 375 and 395 fathom levels from Fortescue's shaft have not given as good results as anticipated. Exploratory work in some of the upper levels is being undertaken with fairly good results.

Cornwall Tailings.—This company was formed in 1910 to buy the old tailing heaps belonging to the Carn Brea and Tincroft company at Camborne. The control is with the Lempriere-Lionel Robinson group, and Arthur Richards is managing director. The report for the year ended February 29 last shows that 137,979 tons, assaying 13·55 lb. metallic tin per ton, was treated, compared with 144,460 tons assaying 16·22 lb. the year before. Two years ago, owing to the depression in the price of tin, it had been decided to treat only the richer parts of the Tincroft dumps, and to cut expenses by omitting re-grinding. On exhaustion of these dumps, the current price of tin was higher, so it was found possible to revert to re-grinding and to bring some of the automatic buddles into use again. Thereby the recovery was advanced from 27% to 31%. Since the close of the company's year the figure has been advanced to 35% on a monthly tonnage of 10,000 instead of 12,000. During the year, the yield of concentrate was 395 tons selling for £30,570, as compared with 432 tons selling for £31,632. The cost of treatment was 3s. 10d. per ton, as compared with 3s. 3d., and the smelter's charges were £35 9s. 8d. per ton of tin as compared with £23 12s. 3d. The working profit for the year was £1465, but after allowing £2000 for depreciation, the year ended with an adverse balance of £534, thus reducing the balance in hand from £4611 to £4077. Out of this accumulated profit, a dividend of 5% is being distributed, absorbing £2500. The policy is to continue to select the richest parts of the dumps. At the present price of tin the reserve of profitable material will only last a year. The remaining parts would keep the plant going for four years or so, but they would only be worked if tin prices advanced.

Weardale Lead.—This company was formed in 1883 to work a group of lead mines in Durham at the head of the river Wear. The galena is found in the carboniferous limestone and it is associated with fluorspar. Henry Louis is the consulting engineer, and H. S. Willis is manager. The report for the year ended June 30 shows that at the Boltsburn mine 3899 tons of lead ore and concentrate was produced, at the Stanhopeburn 213 tons, and at the Sedling 53 tons, making a total of 4246 tons, which was smelted at the company's furnaces. In addition 7740 tons of fluorspar was produced at the Stanhopeburn mine and 2282 tons at the Sedling. The smelter treated also 1027 tons of purchased material. The yield of lead was 3764 tons selling for £104,913, and £5093 was received from the sale of fluorspar. The net profit was £24,548, of which £14,688 was distributed to shareholders, the rate being 15%, free of income tax, and £5000 was written off property account. During the last ten years the dividends have averaged 13%. The company has recently established scholarships at Armstrong College and the Royal School of Mines, particulars of which are given in another part of this issue.

English Crown Spelter.—This company was formed in 1883 to acquire the zinc mines and smelting works of the Crown Zinc Co. previously owned by Richardson & Co. of Swansea. The mines are at Ponte di Nossa, in the province of Bergamo, northern Italy, and the smelting works are at Port Tennant, Swansea. The 'Crown' brand is well known in the English metal trade. The report for the year 1915 shows that the ore after local treatment gave 5722 tons of calcined calamine and 1979 tons of blende. The latter is roasted at the smelting works. After making full allowance for taxes and excess profits duty, the net profit was £49,929, out of which £16,800 was paid as dividend, being at the rate of 20%, and £27,500 was placed to reserve. The benefit of the high price of zinc may be seen by comparing these results with those of 1913, when the profit was only £4044.

Hampden Cloncurry Copper Mines.—This company was formed in Melbourne by the Baillieu group in the year 1906 to acquire the Hampden and Duchess copper properties, in the Cloncurry district of North Queensland. More recently the Trekelano, Pindora, MacGregor, and other properties have been purchased. Smelting was started in 1911, and at first the matte was sent to the Mount Elliott smelter. The company's plant was extended in 1912, and the blister copper produced was sold to Germany. On the outbreak of war the operations were suspended, but by the financial aid of the Commonwealth Bank of Australia, work was re-started in a few weeks. The report for the half-year ended February 29 shows that 43,422 tons of ore was raised, coming from individual mines as follows: Hampden 8037 tons, Duchess 15,998 tons, MacGregor and Wallaroo 6374 tons, Answer 567 tons, and Salmon 12,446 tons. The smelter treated 48,360 tons, and, after refining, the yield was 3850 tons of copper, 957 oz. gold, and 31,110 oz. silver. The net profit was £141,973, of which £70,000 was paid as dividend, being 4s. per £1 share; £12,006 was written off for depreciation, £27,312 placed to equalization reserve, and £30,000 placed to general taxation reserve. The reserve of direct smelting ore at the various mines is calculated as follows: Hampden 32,000 tons averaging 7% copper, Duchess 55,000 tons averaging 13%, MacGregor 71,000 tons averaging 7%, Wallaroo 10,000 tons, averaging 10%, Trekelano 30,000 tons averaging 11%, Answer 5500 tons averaging 9%, and Mascotte 2500 tons averaging 16%, total 206,000 tons averaging 9½%. At the Hampden there is 50,000 tons of concentrating ore averaging 3½%, and a similar amount at Pindora averaging 4½%. The ore at Salmon is not included, as it is more in the nature of a cupriferous flux. The developments at Hampden and Trekelano have given good results, and at Pindora large amounts of concentrating ore are being disclosed. At the Duchess, the 850 ft. level has been in poor ore, and a level is to be opened at 1000 ft.

Waihi Grand Junction Gold.—This company was formed in 1895 to acquire gold-mining properties adjoining the Waihi mine in the northern island of New Zealand. The lodes worked are the continuations in a northeasterly direction of the Martha, Empire, and Royal lodes. Owing to the conformation of the country, the 5th level on the Grand Junction corresponds approximately to the 9th on the Waihi, but as the original outcrops of the rocks containing the lodes are at a much lower level in the Grand Junction than in the Waihi, the zone of impoverishment will be lower in the Grand Junction. A paper on the geological structure of the deposits in the Grand Junction, by Arthur Jarman, the assistant manager, was quoted in our issue of November last. Milling started in 1906, F. C. Brown, of slime-agitator fame, being the manager until 1909, since when W. Frank Grace has been in charge. During 1912 and 1913 the labour troubles caused a serious set-back to operations and profits. The report for the year 1915 shows that 125,800 tons of ore was treated, the assay-value of which was 33s. 3d. in gold and 2s. 9d. in silver. The bullion recovered was worth £202,669, or 31s. 9d. per ton. The net profit was £46,344, out of which £38,439 was distributed as dividend, being at the rate of 10%. As compared with the previous year, the tonnage treated was 10,160 higher, and the yield of bullion was £24,967 less. The fall in the yield was due to the lower grade of the ore raised, the extraction per ton being 7s. less. The development has been restricted on account of the delay in opening the 8th level owing to the water difficulty, and the reserve is estimated at 136,400 tons as compared with 173,000 tons the year before. The assay-values in the Mary and Royal lodes have fallen, but those in the Empire lode have been maintained, and No. 7 level in this section has provided the greater part of the ore treated.

Broken Hill Block 14.—This company has confined its attention for some years to the oxidized lead-silver ores left behind in the upper levels. The report for the half-year ended March 31 shows that 2875 tons, averaging 25·4% lead and 13 oz. silver per ton was mined and delivered to the smelters. This is a much smaller amount than was raised during the preceding half-years, owing to labour difficulties. The prospects of finding further supplies are good. The contract for sale to the Port Pirie smelters expired on December 31, and the ore now goes to the Cockle Creek works of the Sulphide Corporation. The ore sold for £21,284, and the net profit was £10,874. Out of this, £1500 was paid as interest on the preference shares, and £5000 on the ordinary and preference shares. Nothing can be done at present with the reserve of low-grade sulphide ore.

Broken Hill Block 10.—Mining and milling at the mine belonging to this company was suspended on the outbreak of war. The report for the half-year ended March 31 shows that the attention of the manager, O. B. Ward, has been directed chiefly to the testing of the Misima gold mine in Papua. Since the report was issued, cable information is to the effect that the mine at Broken Hill is to be reopened, as the company has obtained an interest in the Associated Lead Smelters.

Golden Kopje Proprietary Mines.—This company was formed in 1912 by the Gold Fields Rhodesian Development Co. to consolidate various interests in the Golden Kopje and Union Jack gold-mining properties in the Lomagundi district of Rhodesia. The deposits are in the banded ironstone, of Pre-Cambrian age, and occur in ill-defined lenses, much disturbed by faulting. Both ore and country rock are soft, and the difficulties of mining are thus increased. The metallurgical equipment was purchased from the Ayrshire mine nearby, but did not give entire satisfaction, and continuous decantation has recently been substituted for filtration. Milling commenced in July 1914. The report for the year ended March 31 last shows that mining has been difficult and that the grade of the ore has proved to be lower than was indicated by sampling. The ore raised and treated was 131,567 tons and the yield was 29,369 oz., realizing £121,078. The working cost was £124,867, the London expenses £1822, and the interest on borrowed money £5123. The loss for the year was £10,694. The issued capital is £448,568, half of which was subscribed in cash. The debt to the parent company is £81,298, sundry creditors £34,916, and development suspense account £6508. The development during the year disclosed 35,421 tons of ore, as against 131,567 tons mined, and 38,547 tons in the reserve calculated at March 31, 1915, was rejected as unprofitable. The reserve at March 31, 1916, was estimated at 157,675 tons, as compared with 292,368 tons the year before. Of this, 150,716 tons averaging 5·2 dwt. was in the Golden Kopje mine and 6959 tons averaging 15 dwt. was in the Union Jack mine. The workings are now in sulphide ore, and the best method of treating this is engaging the attention of H. A. Piper, the consulting engineer, and W. B. Blyth, the consulting metallurgist.

Wanderer (Selukwe) Gold Mines.—This company was formed in 1899 to acquire the Wanderer, Ashton, and other gold mines, in the banded ironstones of the Selukwe district of Rhodesia. Edmund Davis is chairman. The ore is of low grade, and is amenable to direct cyanide treatment, but the financial results have been continuously disappointing. The capital was originally £450,000. In 1909 the shares were written down from £1 to 5s. and additional shares issued. In April, 1915, the sum of £60,000 was distributed among shareholders as a return of capital, and shortly afterward £15,000 was paid as dividend, being at the rate of 16⅔% on the reduced capital. At that time the ore reserves were low and the expectation of further discoveries was small. The report for the year ended April 30 shows that the mines have continued to yield ore for a longer time than was expected. The amount of ore treated was 146,257 tons, as compared with 135,958 tons the year before. Of the amount treated, 16,128 tons came from the Wanderer North, 78,252 tons from the Wanderer South, 28,656 tons from the Kemerton and Trinity, 19,446 tons from the Ashton, and 3775 tons from the Camperdown. The yield of gold was 14,676 oz., worth £60,897, or 8s. 4d. per ton, as compared with £70,751, or 10s. 5d. per ton the year before. The net profit was £3161, which was carried forward. The ore reserve on April 30 was estimated at 44,000 tons, of which 22,000 tons was in the Wanderer, 10,000 tons in the Kemerton and Trinity, 10,000 tons in the Ashton, and 2000 tons in the Camperdown. Noel Griffin, the consulting engineer, considers that the reserve may be double of the figures given, and that it may be possible to maintain the present rate of output until the end of October.

Orsk Goldfields.—This company was formed in 1906 by the Siberian Proprietary to acquire a gold mine in Orenburg, South Russia, introduced by Heyman Orkin. On this property proving of no value, a gold-gravel deposit was acquired near Nicolaievsk in Eastern Siberia. Hooper, Speak & Co. are the consulting engineers, and C. W. Purington, D'Arcy Weatherbe, C. H. Munro, W. H. Lanagan, and William Back have been connected with the gravel property in managerial or advisory capacity. George Lucas Nelson is now the manager. The dredge ordered from New York was delayed in delivery, and did not start operations on the Kolchan ground until 1911. In the meantime a stacker-scow had been put to work on the Pokrovsky property. This was shortly afterward converted into a dredge. The company was greatly inconvenienced by the delay in the delivery of the Kolchan dredge, and subsequently by shortness of capital. It was only in May last that it was possible to declare a dividend. The report for the year 1915 shows that the Kolchan dredge was working 218 days and treated 628,762 cubic yards of gravel for a yield of gold worth £69,084; the Pokrovsky dredge was working 188 days and treated 155,790 cu. yd. for a yield of gold worth £13,060; gold won by tributers was valued at £20,582. The working cost at Kolchan was £24,963, and at Pokrovsky £10,822, while the disbursements in connection with tributers' gold were £15,537. The sum of £13,059 was written off for depreciation of plant, the loss on exchange due to the fall in the value of the rouble was £11,712, and the London expenses were £2110. The balance of profit was £26,944. The method of paying a dividend presented some difficulty, but it was decided to declare dividends of 1·70 roubles on each priority share, of which there are 170,000 of £1 each, and 7½ kopecks on each preference share, of which there are 876,000 of 5s. each. Nothing was paid on the £531,000 ordinary shares. At normal exchange the dividends would absorb £16,826. Shareholders cashing their warrants would suffer the loss due to the fall of exchange, which at the end of the company's year stood at 16·10 roubles as compared with 9 50 par value. Interim dividends have been declared for the current year at the same rates.

Arizona Copper.—This company was formed in Edinburgh in 1884 to acquire copper mines at Clifton, Arizona. Four years ago the scale of operations was enlarged in order that the great reserves of lower-grade ore should be treated, and a new smelting plant was built. The interim report now issued covers the half-year ended March 31 last. The mine and smelter were idle from the middle of September 1915 to the end of January of this year, so that the output during the half-year was only one-third of the normal. The production of copper was 2957 short tons, of which 964 tons was sold as blister, and 1993 tons as electrolytic. The net profit was £137,175, out of which £30,642 was paid as debenture interest and £40,264 allocated to the redemption of debentures. The preference shares received £12,265, and £113,992 has been distributed as dividend on the ordinary shares, being at the rate of 1s. 6d. per 5s. share. The remodelling of the No. 4 concentrator at Clifton has been delayed by labour difficulties and by delay in deliveries, and the flotation plant at No. 6 concentrator at Morenci has suffered in a like manner. It was, however, possible to make a start with part of these plants in April.

Poderosa.—This company was formed in 1908 to acquire from local owners a group of copper mines at Collahuasi, in Chile, not far from the main line of the Antofagasta & Bolivia railway. The mines were described by Robert Hawxhurst in our issue of October 1910. The mines had yielded large amounts of high-grade copper ore. The English company continued by the same methods, and for the first year or so made profits, which were distributed as a dividend. Afterward, when it was desirable to spend money on development, there were no funds available, and the company has since then had a hand-to-mouth existence, without making any divisible profit. The report for the year 1915 shows that the operations have consisted chiefly of removing the remaining ore. There are now no reserves. Exploration on the 9th level revealed no new supplies of ore, but in a winze sunk below this level a small vein containing rich sulphides has been disclosed. This discovery encourages the manager, J. H. Ivey, to continue sinking to the 10th level and to develop the ore-shoot from that horizon. During the year 1915, the amount of shipping ore mined was 3822 tons, averaging 22% copper, and in addition 570 tons of concentrate, averaging 29·2% copper, was produced. The sales of ore and concentrate brought an income of £57,245, and yielded a net profit of £17,025. As the year began with an adverse balance of £20,304, none of the profit was available for distribution. Mr. Ivey reports that the dumps contain 138,000 tons averaging 3½% and that about half of the copper will be recoverable by water concentration.

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CONTENTS.

EDITORIAL

ON November 8 the general subject of Refractories will be discussed at a meeting of the Faraday Society. The first paper will be read by Dr. J. W. Mellor, who has recently done much research work in this connection. Metallurgists should attend the meeting, to give and receive information. Those ready with suggestions and with contributions to the discussion should communicate with the secretary, Mr. F. S. Spiers, at 82 Victoria Street, Westminster.

AT the meeting of the Institute of Metals held last month, a paper was presented by Mr. Ernest A. Smith, of the Sheffield Assay Office, on the 'Development of the Spelter Industry.' This paper was written in competition for the Peter Le Neve Foster prize offered by the Royal Society of Arts. Some alterations, of both addition and omission, have been made, in order that the treatise shall be more suitable to the requirements of the members of the Institute. Thus the section devoted to a consideration of zinc alloys adds to the interest of the paper. The discussion of the paper was decidedly useful, being enlivened by informative speeches by Messrs. Hugh K. Picard, H. M. Ridge, Robert Mond, and W. Rosenhain.

EVERYTHING comes to an end at last, even the evidence and counsels' speeches in gold-mining litigation. The case of the Amalgamated Properties of Rhodesia against the Globe & Phœnix, in which the plaintiffs desired a decision as to the rights to certain veins under Rhodesian apex law, has been of unprecedented length as far as business litigation is concerned, and from the same point of view it even became a serious rival to the Tichborne case. An unpleasant feature of the proceedings was the continual friction, accompanied by angry words, between counsel. Mr. Upjohn, for the Globe & Phœnix, was undoubtedly prolix and theatrical, and other lawyers might have been much shorter and more precise. But that was not the cause of the trouble. Being in a far from robust state of health, Mr. Upjohn was irritated by interruptions and corrections from his opponents, and by the unpleasantly persistent whispered conversations around him. But Mr. Justice Eve held the balance fairly and with good humour. We look forward with interest to his reserved judgment. He has to decide on the question of fact regarding the relation of the lodes, and he has also to interpret the application of the Rhodesian mining law.

SECONDARY enrichment of copper ores affords opportunities for useful study and research at the universities and scientific institutions. Reference is made elsewhere to the work done in America in this direction. We take this opportunity of drawing attention to an excellent paper recently published, describing experiments undertaken to ascertain the precipitation products formed when the descending solutions come in contact with the various copper minerals. The main conclusions are given in our Mining Digest, but the original paper, which constitutes nearly the whole of the August issue of *Economic Geology*, should be consulted.

IN outlining a plan for the centralization of the activities of the various engineering societies in this country, Sir Robert Hadfield suggests that the four societies devoted to mining and metallurgy, the Iron and Steel Institute, the Institute of Metals, the Institution of Mining Engineers, and the Institution of Mining and Metallurgy, should draw closer together, and co-operate for the erection of a building for the accommodation of their offices and for the provision of a common library and meeting hall. We shall take many deep breaths, and pulls at our pipe, before expressing an opinion with regard to the proposal. We are all for emphasizing the unity of interests of these four societies, but the idea of housing them in one building is quite another thing. We doubt whether any of the societies would feel justified in embarking on the necessary expenditure, and the choice of a site agreeable to all parties would prove a difficult matter.

CONSIDERABLE space is devoted in this issue to South African affairs. Mr. H. Foster Bain continues his discussion of labour problems, describing the methods of housing and feeding the natives on the Rand, in Rhodesia, and in the Belgian Congo, and the medical arrangements for keeping them in good health and condition. He contrasts the relative advantages and drawbacks of life in the compounds and in the native villages, and on the whole is in favour of the latter system. The establishment of such villages on the Rand has not as a rule been advocated, as it is held to be inadvisable to have a large native community in the neighbourhood of Johannesburg. A trial of the system is, however, being made at New Modderfontein, and the results will be well worth watching. Another South African topic referred to in this issue is the recent discovery of a diamond deposit at Kameelfontein, near Pretoria. We quote at some length from the first authoritative account of the deposit, written by Dr. Percy A. Wagner. The most recent news from this field is that a diamond weighing 300 carats has been found. A third South African subject treated in this issue is the tracing of the Nigel reef farther to the south of Heidelberg than has hitherto been proved.

TREATMENT of tin slime offers an attractive problem to all mining men. Many have been the attempts to improve extraction by applying new ideas and machines, but in one case after another the results have not disclosed any substantial improvement. The latest testimony in this connection comes from Mr. E. J. Way, consulting engineer to the Rooiberg company, operating in the Transvaal, who says that for the treatment of tin slime there is nothing like rag frames. It seems to us that the obloquy nowadays attached to the imperfections of the old tin-dressing methods is quite unmerited. The limits of efficiency of water concentration as applied to tin slime were reached long ago. The losses are no greater than those experienced in the treatment of finely divided copper ores. Float gold, and gold intimately mixed with sulphide minerals, was not satisfactorily treated by amalgamation. The cyanide process came to the rescue of gold metallurgy, and flotation has filled the gap in the saving of copper, lead, zinc, and other sulphide ores. In the same way, an entirely new process is required to supplement water concentration in connection with tin ores. Naturally much may be expected of those who are now engaged in systematic research on the tin-dressing problem, and they will undoubtedly be able to define the present limits of efficiency of water concentration and to suggest certain improvements. But their scope and opportunities are not confined within these narrow lines. The wider possibilities present a more attractive problem.

EVERY month we devote two pages to the metal and chemical markets, giving outlines of the course of prices and production of the commercial metals, and of the ruling prices of the chief chemicals of interest to the mining engineer and metallurgist. In ordinary times there is no difficulty in preparing these statements, though even then we are not always quite sure whether the information we give is for the benefit of the user, the producer, or the middleman. In war times, however, the position is very different, and we confess that the prices quoted at present are of little, if any, value. For instance, the official price of copper is fixed every day on stray transactions, and sometimes there is not a single transaction at all. But though these prices have little basis, they have a wide influence, as they fix the terms of delivery under long-time contracts, so for this reason they have to be recorded. Then again the Government asks us not to make mention of the prices of iron ore or of wolfram and molybdenum concentrates. Aluminium and antimony are controlled by the Government, and supplies can only be obtained by an act of grace. Official prices are fixed for pig iron, but much more has to be paid by an outsider for stray lots. As for the chemical prices, we regret that several of our readers have found them distinctly misleading, for, as they say, it is no use quoting a specific price for a chemical if there is none on the market. A firm under government control can generally obtain its supplies at the advertised price, but an outsider has to trust to luck, and pay through the nose for chance supplies from abroad or from second-hands at home. This month we have inserted a warning paragraph at the head of the column devoted to prices of chemicals in order that the actual conditions of trade may be duly appreciated.

ANOTHER chapter in flotation litigation is closed by the delivery of judgment by the United States District Court for Delaware in favour of Minerals Separation in the action against the Miami Copper company. No doubt an appeal will be lodged with the Circuit Court, and eventually the case will surely go to the Supreme Court. The other suit brought by Minerals Separation in the United States, that against James M. Hyde, is likely to come before the Supreme Court this month. When the case was first heard in the District Court for Montana, judgment went for Minerals Separation. This was reversed in the Circuit Court of Appeal. The final arguments and opinions will, therefore, be particularly interesting. The two actions brought by Minerals Separation against Mr. Hyde and the Miami company respectively differed in essential details. The process used by Mr. Hyde is on much the same lines as that of Minerals Separation, while that employed by the Miami company is the Callow method, in which the lifting is done by bubbles of compressed air driven from below. It is not necessary on the present occasion to enter into details of the arguments in the Miami case, for we gave a précis in our issue of January last, together with a full description of the Callow process.

SINISTER attacks on the boards of directors of mining companies have been too prevalent of late. The underground fires are still smouldering in connection with the Zinc Corporation, but we have nothing to add to our criticism of the agitation, printed in our July issue. Now the Amalgamated Properties of Rhodesia is the victim of onslaught by circular. One of the complaints in this case is that certain arbitration proceedings have been postponed for too long a time. Surely the agitators are aware that the company has been occupied for over a year in litigation with the Globe & Phœnix, and that it is best to take one of these things at a time. We had hoped that the day of irresponsible attack by people with small holdings was over. There is really no excuse for their existence. The daily newspapers do excellent work in drawing attention to defects in business proposals and methods, and it is seldom that a real blunder is not exposed in this way. If a shareholder has a legitimate grievance, it is rare that the board refuses to give due consideration, but naturally no serious negotiations would be undertaken by the directors unless they were assured of the bona-fides of the shareholder. We may take it that no agitation by circular is prompted by altruistic motives. Usually those who join are sorry afterward, when the status and the aims of the agitators are disclosed.

RESEARCH in connection with mining and metallurgical subjects is in a backward state in this country. The Geological Survey has until recently fought shy of economic geology, though its original object, and that of the Jermyn Street Museum, was to help the commercial community. The Geological Society still devotes itself largely to pure science, but it must be said that the society as a body is not responsible for this comparative neglect of economic geology. The blame lies chiefly with our mining engineers, who do not give the society the practical support due from them. The researches at the Geophysical Laboratory at Washington are often quoted as examples of how they do things better in America. It is to be remembered, however, that this laboratory exhibited the same aloofness from trade in the early days, for the first researches were devoted to examinations and classifications of felspars. It was not until the copper companies came forward with funds and suggestions that the previous advice of outside geologists was taken and a sulphide campaign commenced. When the Imperial Department of Minerals and Metals is organized, several scientific subjects will demand investigation. For instance, the origin of Rand gold might be suitably considered, and the mapping of Cornish lodes might be undertaken. We should like to see Dr. Malcolm Maclaren or Mr. F. P. Mennell in charge of the latter work, for they not only have the ability to collect accurate information, but the courage to give direct recommendations for its practical application. As for the Rand gold problem, Dr. E. T. Mellor might be induced to come back to the Union Geological Survey or to a similar post, and then he would be able to give to the community the talents that are now devoted to the interests of one particular group.

WE take pleasure in presenting this month an article describing the methods employed in mining the auriferous deep leads in Victoria. Those of our readers who only know of mining operations through the success, or otherwise, of companies floated in England, may wonder why we afford so much space to the subject at this time of day. It is true that some of the ventures of ten to twenty years ago were in the hands of irresponsible promoters, but, on the other hand, many firms, such as Bewick, Moreing & Co., put the best quality of engineering talent into the work, and their failure to attain profitable results was due entirely to the immense flow of underground water. This water difficulty still stands in the way of progress. Though improvements have of recent years been made in pumping plant and though the cost of power production has been greatly reduced, it is doubtful whether sufficient improvements have yet been introduced to make these deposits profitable to work. For this reason it may be that the time is not ripe for reconsidering the question of developing the deposits on a large scale. A number of properties that are not troubled with too much water are still being worked, a few of them profitably. Hundreds of miles of these deep leads are unworked and untested. With systematic boring, based on an intelligent comprehension of geological and physical conditions, the deposits afford opportunities for the gold miner in Victoria. The lode mines and shallow gravels are gradually being exhausted, and attention will in the future be directed once more to the deep leads, provided the cost of labour does not become too high. The author of the article, Mr. M. T. Taylor, at present manager at the East Pool & Agar, writes on a subject with which he is perfectly conversant, and he is to be thanked for putting his experiences on record.

Bedford McNeill.

The late Bedford McNeill, whose death we all deplore, occupied a position in the mining profession that was in a sense unique. After a brilliant career at the Royal School of Mines, he became associated with the late John Darlington, and did excellent service in Colorado, Mexico, and other parts of the world. But the rough and tumble life of the pioneer was not congenial to him, and we soon found him established at 25a Old Broad Street as secretary of a number of the Darlington companies. Here he became impressed with the necessity for a new cable code more fitted for mining purposes than any then available, and he proceeded to devote his energies to its preparation. His first code, published in 1895, was at once appreciated. Its ready acceptance spurred him to continue his labours for the benefit of his profession, with the result that he produced an entirely new and more elaborate code in 1908. During the last dozen or more years he was not so largely occupied with company business or with consultative practice, and he was thus able to devote his time to public or semi-public matters of interest to the mining fraternity. For one year he served as president of the Institution of Mining and Metallurgy, but during all the years he was just as ready to give his services to the Institution. His amiable temperament and honourable punctiliousness made him an ideal negotiator when delicate and confidential matters were under consideration. This application of his genius did not bring him into the lime-light, so that the average engineer will never know the extent of the debt the profession owes to him. His work was by no means confined to the Institution, for he was in close touch also with the Geological Society, of which he was treasurer for the last four years, and with the Iron and Steel Institute, at the meetings of which he was one of the most regular attenders. It was largely his friendship with the late Bennett H. Brough that drew him to the Iron and Steel Institute, and we know that he gave much unofficial help in connection with the duties of Secretary, for his friend's sake. The writer of this paragraph wishes to add his testimony, based on an experience of twenty-five years, to Mr. McNeill's high character, and to put on record his gratitude for advice and assistance always freely and cheerfully given.

Trade after the War.

A certain public man of the versatile-politician type has recently said : " Take care of the war and the after-the-war will take care of itself." As his other catchwords and prophecies have in the past been utterly falsified, we are only amused by his latest dictum, and we quote it merely to show that he is quite out of touch with the new spirit in England. Just as our military system has been transformed, and our old glories on the battlefield have been revived, so have our leaders in trade and technology taken their courage in both hands, and have determined to reorganize the business methods of the Empire. In fact, we have at last answered the call of the King : Wake up, England ! Our enemies hate us for this new movement as bitterly as for the efficiency of our army, and even neutral nations are beginning to feel thoughtful.

Let us consider some of the evidence of this awakening to our responsibilities. We take first the letter addressed to the Advisory Council for Scientific and Industrial Research by the joint committee of the four societies representing mining and metallurgy, the Iron and Steel Institute, the Institution of Mining Engineers, the Institution of Mining and Metallurgy, and the Institute of Metals. This letter we print in full on another page. The suggestion of the committee is that a Government Department of Minerals and Metals shall be established, and that it shall be in intimate connection with similar departments in our dominions beyond the seas. The advantages of such a department are so obvious that the proposal will be received unanimously. At the same time its formation will not remove the desirability of the establishment of an independent Chamber of Mines in London, the duty of which would be to make business recommendations to the Government and to the new Department.

The next item of evidence is the inauguration of the Federation of British Industries. The objects of this new association are vast; briefly, its functions are to promote the interests of the manufacturers, both within their own ranks, and in their relations with labour on one hand and with the Government on the other. The prevention of overlapping of work and needless duplication and competition, the standardization of models, and co-operation in connection with export trade will all receive careful attention. The relations with labour promise to provide valuable opportunities for social reform. The greatest labour-reform of all will come when both masters and men are induced to allow each individual worker to put forth all his energies, and for his remuneration to be equitably and generously adjusted, with no cutting of the clever man's rate of commission on the part of the masters and no limiting of output on the part of the men. No doubt this crucial point in connection with the future efficiency of British methods will receive due consideration by the Federation.

A third example of the intended expansion of operations is provided by the proposal to establish a British Trade Bank under the auspices of present banking and mercantile institutions, and with the assistance, financial and otherwise, of the Government. Such a bank would have the function not only of financing industrial enterprises at home and abroad, but also that of passing judgment on various commercial proposals introduced to the public. If we have any criticism to make with regard to this bank, it is that too much Government control is not advisable, and that its destinies should be in the hands of the banks and business houses.

Another evidence of the desire of the manufacturers of this country to conduct their foreign campaigns to the best advantage is to be found in the establishment of such businesses as those of the British Engineering Company of Russia and Siberia Limited, and the Anglo-Chinese Engineers Association Limited. Both of these companies are organized and managed by engineers, who are in touch with Russian and Chinese requirements and are qualified in every way to represent and push the interests of the home firms. Both of the companies have opportunities for expansion of their activities, and more will be heard of them.

Finally we may instance the allocation of some of the Kitchener Memorial funds to the foundation of travelling scholarships. The object of these scholarships is to prepare young men, who have served in the war and are sons of deceased or disabled officers and men, for a commercial career by giving them the preliminary opportunity of travelling in the countries of our Allies, and studying the languages, business methods, and trade requirements. The Kitchener Memorial is under the guidance and direction of the Lord Mayor of London, and for this reason its administration will be discreet, and holders of the scholarships may be accounted fortunate men with a bright outlook for life.

The instances here given are sufficient to show that the after-the-war campaign is being prepared in all seriousness. The manufacturers are laying plans for future activities when the war demands are over, and are letting the world know the nature of the business they will then desire to do.

The Alaska Treadwell Mines.

The report on the Treadwell group of mines by Messrs. H. C. Perkins, Hennen Jennings, and F. W. Bradley, to which we referred last month, has arrived in this country, and very unpleasant reading it provides. These engineers were deputed to examine the properties of the Alaska Treadwell, Alaska United, and Alaska Mexican, companies with a view to settling an equitable basis for amalgamation. But they have done more than this. They have disclosed the precarious condition of the mines, as it is affected by the low grade of the ore developed, by the dangerous condition of the workings, and by the inability of the mines to supply the mills. Those who have read the recent monthly and yearly reports were aware of the disappointing nature of developments at depth, and of the care that had to be exercised lest some part of the reserves should be lost, but the full gravity of the situation was not appreciated. The engineers' report as published is not accompanied by copies of the maps and plans presented to the board, and for that reason the exact position cannot be gauged. All we can do is to quote a few of the conclusions and recommendations. At the Treadwell the yield per ton during the first half year of 1916 dropped to \$1·66, as compared with an average of \$2·41 during the previous life of the mine, and the operating profit per ton dropped to \$0·33 as compared with \$1·10; at the 700 ft. mine of the United, the yield per ton dropped to \$1·69, and the profit was changed to a loss of \$0·29; at the Mexican the yield dropped to \$1·31 and the loss was \$0·22 per ton. We quote the results at these three properties together, as the mines are immediately adjoining and contain the chief orebody of the Treadwell group; the Ready Bullion property of the United is at some distance away and is not of the same importance. As regards ore reserves, the last yearly estimate gave approximately 7,000,000 tons in the Treadwell, 1,000,000 in the Mexican, and 5,000,000 in the 700 ft. According to the present estimate 3,000,000 tons is returned as recoverable ore at the Treadwell, likely to yield a profit of \$0·46 per ton, 2,400,000 tons at the 700 ft., expected to yield a profit of \$0·28, and 50,000 tons at the Mexican that may give a profit of \$0·80 per ton. The figures for the reserve at Treadwell have been drastically reduced, owing partly to large amounts being in unrecoverable pillars and also to some of the ore having been lost by caving. Moreover, the probability of further loss by caving is not left out of calculation. The engineers point to the inability of the mine to keep the mills in full occupation, and since their report was prepared one of the Treadwell mills has been put out of commission. As we have already said, the dangers of caving were always recognized, and in fact this was the reason why it was decided a year or two ago to leave a solid pillar 200 ft. deep below the 1750 ft. level, and to start a new mine at about 1950 ft. Developments below this depth have been generally disappointing, but diamond drilling has given encouraging results, and it is recommended that sinking shall be continued to 2700 ft. The cost of this new work is estimated at $1,115,000, and from 3 to 5 years will be occupied in completing it. Both the Central and the Combination shafts will be sunk to the deeper levels. There is some anxiety as to the security of the Central shaft, and if serious shifting of the ground occurs, sole reliance will have to be placed on the Combination shaft, until an entirely new shaft in safer ground is sunk. Some of our readers and many of the shareholders will want to blame somebody for the serious state of affairs that has arisen, but such an attitude is ungracious and entirely unwarranted. It must be remembered that it is thirty years since the deposit was first worked, and that in those days the development of a wide low-grade orebody of this character constituted a little understood problem. At first the ore was extracted by open-cut, and subsequently underground mining was undertaken by methods that were orthodox at the time. In the light of more recent knowledge and experience in connection with the mining of big low-grade orebodies, the engineers, if they could start over again, would no doubt adopt a different system of mining. In any case, it must be remembered that in the early days of the mine such a thing as persistence of a low-grade orebody in depth was not contemplated, nor was it expected that mining could be continued below sea-level. These conditions made the directors shrink from developing too far ahead, but it is clear now that a system like that at the St. John del Rey, whereby the levels are driven 300 ft. apart instead of 100 ft., would have had its advantages. Taking everything into consideration from a broad point of view, we come to the conclusion that, though the present state of affairs is alarming, the policy of the engineers of the Treadwell group has always been sound enough when judged by the state of knowledge at the time. Shareholders have already been well repaid for their money out of ore that in many places would not be profitable at all, and they must remember these past benefits, while looking to future profits in a chastened frame of mind.

Explosives in Australia.

The Cape Explosives company is to be congratulated on its victory in Australia over the prejudices of the labour unions. Ever since the company attempted to gain a footing in Australia, the fact that it employed coloured labour was a serious obstacle to its progress, for the politicians, in their hatred of cheap labour, imposed a discriminating duty against its products. We judge that this prejudice was encouraged by competitors, for even now we see the words "No coloured labour employed" in the advertisements of a powerful rival firm. The Australian workman's antipathies have been turned in other directions since the war began, so that, more recently, the prejudice has been against the explosive manufacturers who used to have German associations. Thus the Committee recently appointed by the Australian Government for the purpose of suggesting modifications in the import tariffs had no difficulty in taking a sympathetic attitude toward the Cape Explosives company when it petitioned to be put on the same footing as the English makers of explosives. One item of evidence presented to the Committee with regard to black labour was particularly interesting. It was shown that certain unskilled work was done by the natives at the Cape factory for a weekly pay of £1, whereas similar work was done in Scotland and Germany by girls, who are paid 7s. per week. The argument against cheap competitive labour therefore fell to the ground. The Committee decided to recommend that in future the Cape company shall be placed on the same footing as regards tariff as the English companies, and thereby a competition advantageous to the mines will be fostered.

The Cape Explosives company has always pursued an independent policy. It was formed by Cecil Rhodes for the purpose of obtaining cheaper dynamite for the De Beers diamond mines. In those days the price of explosives in South Africa was governed largely by the monopoly granted to the Modderfontein works by the South African Republic. Rhodes inaugurated the Cape company in order to introduce competition. A factory was built at Somerset West, near Cape Town, and a scale of prices was fixed calculated to yield 6% profit after allowing for amortization. The prices were thus far lower than those previously paid by the diamond mines. The building of the factory was commenced just before the Boer war. Foreseeing the opportunities after the war, the company decided to expand its scale of operations and to undertake to supply part of the requirements of the gold mines on the Rand. At the present time its proportion of the explosives delivered to Transvaal gold mines is about one-half, and the Modderfontein factory and the Kynoch factory at East London supply another quarter each. It will be seen, from these remarks, that the Cape company has had an important influence in the cheapening of explosives in South Africa. Its extension of influence in Australia will be grateful to the mining communities.

Valuing Mine Products.

In estimating the value of a base-metal mine and the prospective profits obtainable, the engineer has to exercise sagacious judgment when fixing a basis of prices for the metals to be recovered. By development, sampling, and assay the proved and probable reserve may be calculated, and by consideration of dressing and smelting methods the total extractable metal may be ascertained. But the investor also wants to know the profit to be expected. The winning of the metals in the reserve may be spread over many years, and to prophesy the course of prices for copper, lead, zinc, and tin so far ahead is an impossibility. It is well, therefore, on all occasions to base calculations of profit on a reasonable minimum, and to indicate the extra profit to be reaped for every pound or five-pound advance in the price of the metal mined. This is in fact the usual procedure, and it is seldom that a company arouses false hopes by the assumption of undue optimism. The problem is, of course, more difficult than usual at the present time, owing to the unnatural inflation of metal prices consequent on the transfer of consumption from industrial to warlike uses. In fact no attempt is made at present to foretell the future market, and recourse is had to the prices prevailing during the year preceding the war.

For short-dated estimates, or for estimates of the value of metals already produced but not sold, it is not necessary to adopt the same rigid principle, and it is permissible to exercise a reasonable amount of judgment based on the course of the markets. Many companies, particularly those in Australia, that usually have a large reserve of undivided profit, do not adopt this closer valuation but carry, for instance, copper forward at cost price or at the minimum experienced during their existence. It is not so much to these big and prosperous companies, however, that we refer. We may instance, for the sake of our present contention, a tin-mining company working in difficult times. When drawing up a yearly profit and loss account such a company is justified in approximating to current prices in valuing the unsold tin concentrate in order that funds may be released for the payment of a dividend. Take also a company engaged in establishing a copper-smelting industry in a new country. Here it would be permissible to make the best of things in a financial statement. A recently published statement of a quarter's operations at a gold-copper mine provides an example of the advantages that would accrue if such a policy were adopted. The circular in question announces that the operations resulted in a financial loss, but a note is appended explaining that in the calculations the price of copper is taken at £50 per ton. Surely it would have been justifiable to take the price nearer the average ruling at present, or one similar to that realized during the previous period. As it is the careless reader of the circular (and there are many careless readers abroad in the land) obtained the impression that the mine was not paying its way, and no amount of explanation can ever remove it. This is, of course, an exceptional case, and it may even be called an exaggerated case. Such examples, however, indicate the limits within which the application of an excellent principle proves serviceable. The case will have served a useful purpose if it impresses on engineers that, while low basal prices are necessary in calculating profits far ahead, it is permissible and even desirable for estimates of current profits to be founded on closer approximations to the prices ruling at the time.

REVIEW OF MINING

Introductory.—The proposals of the Australian Government with regard to the taxation of profits has caused considerable perturbation among mining companies and shareholders. Much of this anxiety has been entirely unnecessary, and was based on the misinterpretation of official speeches by the cable correspondents. From these messages it was made to appear that for the coming year the whole of the profits of a company over 7% were to be appropriated by the Government. On inquiry in quarters likely to be well informed we find that the tentative proposal is to appropriate all except 7% over the profits of pre-war time. The Australian Government has by no means settled the question and in fact is still inquiring into the subject. In the metal trades, prices have shown little variation during the past month. The copper market has received renewed strength by the statement that the Allies have ordered from America a further 200,000 tons for delivery during the first half of 1917. Of individual mining investments the Treadwell group in Alaska have been most prominent, owing to the unpleasant outlook foreshadowed by the engineers' report just issued. The recrudescence of submarine activity, this time off the coast of the United States, has caused a serious set-back to the recent optimism, for no one can tell the effect on the delivery of necessary supplies of all sorts from America.

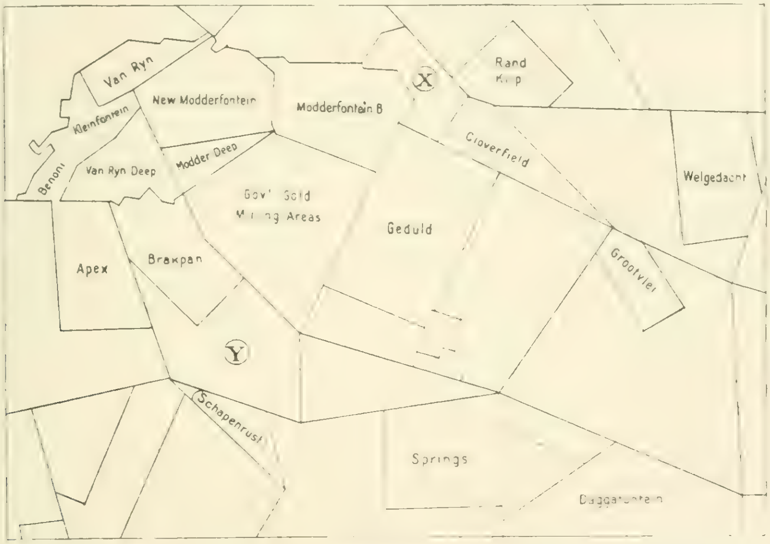
Transvaal.—The output of gold on the Rand during September was 744,881 oz., and in other districts 26,686 oz., making a total of 771,567 oz., worth £3,277,408, as compared with 752,940 oz., 28,210 oz., 781,150 oz., and £3,311,118 in August. The number of natives employed on the gold mines at the end of September was 197,734, as compared with 194,112 at the end of August, and 204,833 at the end of September a year ago. The number employed at diamond mines was 6527, as compared with 5146 at the end of August, 3339 at the end of July, and 132 at the end of December last.

Last month we mentioned the excellent results obtained in recent development at New Modderfontein. The report by Mr. H. Stuart Martin is now to hand and details are available. In the deep-level part of the mine served by the new circular shaft, the position has greatly improved. A year ago a million tons of ore on the 11th and 12th levels had to be removed from the estimate of reserve owing to the low content. Further examination of this ground has not caused Mr. Martin to change his opinion of it. To compensate, the results on the 13th and 14th levels have been good, and as the drifts get away from the shaft in both directions the quality of the ore improves. The best developments, however, have been in the upper part of the mine, in the 8th, 9th, and 10th levels. On the 9th level the ore recently disclosed has been consistently rich. It is interesting to note that in certain parts of the lower levels leaders of profitable ore have been found above the reef. The metallurgical plant to treat ore hoisted through the circular shaft will not be ready before the end of 1917, owing to the machinery makers being engaged on war work.

The scale of operations at Nourse Mines was expanded a year or two ago so as to reduce the cost per ton and so to mine profitably the low-grade ore. It has been found recently that even under these conditions much of the Main Reef is not worth working. The West mill, which was treating Main Reef ore chiefly, has therefore been closed, and only the Deep mill is now running. The capacity of this mill has been increased at little expense, and toward the end of this month the rate of treatment will be raised to 50,000 tons per month. The elimination of unprofitable Main Reef has reduced the reserve by 783,100 tons, now standing at 2,169,300 tons, but on the other hand the average assay-value has been raised from 5·7 dwt. to 6·2 dwt. per ton.

The first sitting of the Government Commission on State Mining was held on October

4. The first witness was Mr. R. N. Kotze, whose views on the subject are naturally of great interest, seeing that he has recently investigated the future possibilities of the Far East Rand. Mr. Kotze is not in favour of state mining. He emphasizes as a drawback the possibility of financial loss, and he is sure that the state would never pay adequate salaries to attract the best men. Moreover the relations between the state and the miners, as employees on the one hand and as voters on the other, would become difficult in case of labour disputes.



MAP OF THE FAR EAST RAND, SHOWING THE POSITION OF PROPERTIES NOW BEING OFFERED ON LEASE BY THE GOVERNMENT.

The Transvaal Government is offering the leases of two tracts of unproved ground in the Far East Rand. The first marked *X* on the accompanying map lies to the east of Modder B and to the north of the Geduld. This ground consists of 651 claims, equal to $1\frac{1}{2}$ square miles. The other marked *Y* lies to the south of the Brakpan and Government Gold Mining Areas, and consists of 1812 claims, equal to $4\frac{1}{4}$ square miles. Profiting by recent failures to interest capital owing to the severe terms proposed, the Government now leaves the onus of suggestion to the capitalist with regard to the share of profits to be paid to the public treasury. The offer is open until October 31. The *Y* ground seems obviously to provide an opportunity for the Rand Selection Corporation, the new name of the Transvaal Coal Trust, for it could be advantageously worked as a deep to the Brakpan; and an amalgamation of the *X* ground with the Rand Klip of the Anglo-French Exploration and the Cloverfield of the Neumann group would make a good business proposition.

Last month we mentioned that the developments at the Nigel gold mine at Heidelberg were so unfavourable that the future is uncertain. The directors asked Mr. Percy Cazalet, consulting engineer to the Central Mining group, to make an examination. His report just received makes gloomy reading.

Sir Sigmund Neumann had been out of direct control in South African mining for so long that his death last month did not affect the market in any way. His firm had an important say in the marketing of diamonds, and was identified by name, though not always in full technical control, with several gold mines on the Rand, such as the Wolhuter, Knight Central, and Witwatersrand Deep. The Witbank colliery also belongs to the Neumann group. He and his associates built Salisbury House, and were pioneers in connection with modern office building in London. Sir Sigmund was born in Bavaria in 1856 and went to South Africa in the early days. For many years he had resided in England.

The property of the Rooiberg Minerals Development company is covered with tin alluvium, and attention has recently been devoted to the recovery of cassiterite by sluicing. The removal of the alluvium will have an additional advantage in that it will expose the rocks below and thus an excellent opportunity will be provided for prospecting for other tin lodes. The developments at the Rooiberg mine continue to give satisfaction, and the reserves are well maintained. During the year ended June 30 last, 1025 long tons of tin concentrate averaging 69% metallic tin was extracted from 36,460 short tons of ore and accumulations containing on the average 3% metallic tin. Of this 78% was recovered in dressing.

The Areachap copper and sulphur mine has been reopened by a Johannesburg syndicate. The mine is situated near Upington, in the Cape Province, not far from the southeast corner of 'German' South West Africa. Until the recent railway extension, the mine was in an isolated position, being 170 miles over the desert to Prieska. The previous owners shipped oxidized ores and rich sulphide to Swansea, but the cost of transport was prohibitive. They also sank two shafts, 1100 ft. apart, and proved the existence of a primary zone of sulphide, chiefly pyrite. The lode is wide and the pyrite massive, so that the ore is valuable for its sulphur content. It is stated that a contract has already been made with one of the African explosive companies, probably Kynoch's at East London, for a regular supply of this ore. The mining work is in the hands of Mr. G. H. Blenkinsop.

Rhodesia.—The output of gold during August was valued at £338,001, as compared with £322,365 in July and £344,493 a year ago. The Cam & Motor showed an advance in the output from £16,446 to £19,223 from the same tonnage of ore. The output at the Fred mine of the Transvaal & Rhodesian Estates is gradually advancing, gold worth £7036 being extracted from 1720 tons, or 81s. 10d. per ton. The Golden Kopje continues to work at a loss, for though £10,108 was extracted from 11,801 tons of ore, the working cost was £11,371. The return at Lonely Reef was good, £14,896 being obtained from 5200 tons of ore, or 57s. 3d. per ton, at a working cost of £8800 or 33s. 10d. per ton.

The Eileen Alannah has paid its first dividend, £20,500 being distributed this month, at the rate of 5%. Directors and engineers are to be congratulated on having paid for the new metallurgical equipment out of income. The total cost was about £75,000, of which £40,000 was provided out of the profits for 1915. The ore is characteristic of the Rhodesian arsenic and antimony belt, and the devising of an efficient plan of treatment was by no means easy. Mr. H. Wiley continues his efforts to improve the recovery.

West Africa.—The output of gold during August was worth £125,143, as compared with £128,574 during July and £139,364 a year ago.

Last month we mentioned that the operations at the Ashanti gold mines were hindered by the delay in delivery of anthracite for the gas-producer plant. A cable was received early this month to the effect that supplies reached the mines on September 27, and that the October yield is expected to be normal. The output during August was £35,060, and during September £37,383, as against an average of £40,000.

The output of the Rayfield company is gradually increasing, and for September the figure was 70 tons, the highest yield of any individual company in Nigeria. The manager, Mr. J. M. Iles, is now in London arranging for an extensive boring and prospecting campaign.

The Niger Company was able to present a favourable report at the meeting of shareholders held last month. The effect of many adverse conditions due to the war were counterbalanced by the elimination of German competition. The volume of water in the Niger was satisfactory during the year, thus facilitating river traffic. In spite of the difficulty of obtaining constructional parts, the steamers were all kept in good condition. The company holds exclusive prospecting licences over 57 square miles, and 13 mining leases over 4615 acres. The output of tin concentrate so far during 1916 has been 188 tons as compared with 184½ tons during the whole of 1915.

Australasia.—The states of Victoria and New South Wales have recently experienced rains that were quite out of the common. Agriculture and cattle and sheep farming will greatly benefit. The war taxation proposals are mentioned in our introductory paragraph.

In our last issue we mentioned that the taxation of the Broken Hill Proprietary for the half-year ended May 31 had risen enormously. The report has since come to hand and we find that the provision for income tax was £117,035, as compared with £14,437 during the previous period. The gross working profit was £398,191, as compared with £275,477, and the dividend in both cases was £118,100 or 25%. It will be seen therefore that nearly the whole of the excess profit was taken as tax.

At the Hampden Cloncurry mine a cross-cut from No. 3 shaft on the 500 ft. level has intersected massive cupriferous pyrite. Over a width of 66 in. the ore averaged 7% copper at the point of intersection. Later news is to the effect that the south drift from this point has been advanced 11 ft., and that the face has an assay-value of 19% copper over 6 ft.; the walls are not yet exposed. The north drift has been advanced 10 ft., with an assay-value across 5 ft. of 5% copper; the foot-wall has not been exposed. The copper content is higher than at other parts of the orebody on the same level.

Work at the Mons Cupri mine in northern West Australia is progressing favourably. Shipments of high-grade oxidized ore commenced on August 28. The copper produced from this ore is sold as 'best selected' and commands a premium similar to that on electrolytic. The directors of the company have made financial arrangements whereby the output of ore will be increased.

It is three years since Dr. Malcolm Maclaren defined the limits of the orebody at the Kalgurli mine. Twelve months ago the gradual exhaustion of the richer reserves commenced, and the profits and dividends were reduced accordingly. Mr. R. S. Black, the manager, now warns shareholders of a further approaching drop in the profits. There remains in the mine only a limited amount of high-grade ore, and when this has gone, the margin of profit will be very small, even when the mill is worked to full capacity. The area owned by the company is not extensive, and it has already been completely prospected, so that there is no probability of any further discovery. During the year ended July 31, 119,180 tons of ore was treated, for a yield of £194,795, as compared with 125,990 tons and £249,878 the year before. The yield per ton fell from 39s. 8d. to 32s. 8d. The cost of development, mining, and treatment was 22s. 10d. as compared with 22s. 7d. Serious increases in the cost of materials and labour are anticipated.

The Great Boulder Proprietary has abandoned its option on the Magdala-Moonlight gold-mining property at Stawell, Victoria. Altogether 62 drill-holes were driven, at a cost of £6000. The deepest bore went down to 1660 ft. The lode is wide, but the gold content is irregular.

The council of science and industry of the Victorian Government has decided to conduct investigations into the occurrence of gold at Bendigo. The field work will be done by Mr. F. L. Stilwell, lately geologist with the Australian Antarctic expedition, and the advisory committee on the subject will consist of Professor Skeats, Mr. Hyman Herman, and Mr. E. C. Dyason.

The state coal mine at Wonthaggi, Victoria, is well known. New South Wales has followed suit by establishing a similar enterprise at Lithgow. Here 40,000 acres of Crown land has been appropriated for the purpose. Borings have proved the existence of a 6 ft. seam of coal, and so far 240,000,000 tons of coal is assured. The chief customer will be the state railways.

India.—Demand for iron and steel is so keen that the Tata works are operating at full capacity and the company contemplates increasing its output from 12,000 to 30,000 tons per month. This will involve building two blast-furnaces, plate mills, sheet mills, and probably other plants to diversify the product.

The driving of the Tiger tunnel at the Bawdwin lead-zinc-silver mine of the Burma Corporation was completed on September 25, and within a short time it will be available for hauling ore.

The results at the North Anantapur mine have been disappointing lately. During the year ended June 30 last, the yield per ton was only 8·6 dwt. per ton as compared with 13 dwt. the year before. As an offset for this decrease of content, the working cost per ton was reduced from 30s. 7d. to 22s. 4d. The total yield for the year was worth £56,209, obtained from 32,390 tons of ore. The sum of £7531 was distributed as dividend, being at the rate of 22½% on the £25,000 preference shares and 2½% on the £76,253 ordinary shares. The development during the year has been unsatisfactory. The chief work has been done on the 950 ft. level north of No. 5 shaft, and the ground has been found to be much broken and of poor quality. In all probability the tonnage mined will show a decrease before long, owing to the wider stopes being exhausted, but the richer and narrower parts of the lode will then be mined, and the gold returns will be maintained. Active development is in hand with the object of discovering new orebodies.

Cornwall.—The developments on the new Rogers lode at East Pool & Agar continue to give remarkable results. On the 190 fathom level the west drift is in ore averaging by vanning assay 55 lb. tin and wolfram per ton over a width of 6 ft. exposed, and the east drift is in ore averaging 157 lb. tin and wolfram over 6 ft. exposed. On the 212 fm. level, the west drift is in 158 lb. ore over 6 ft., and in a rise above this level the vanning assay is 59 lb.

Siam.—The annual report of the Renong Tin Dredging Company shows a greatly improved condition of things, with a profit of £30,745 as compared with a loss of £18,009 a year ago. That loss was caused by breakages in the two new dredges, time and money spent in overhauling the older dredge, and other reasons. The manager, Mr. Frank Nicholls, is able to report that the working of the dredges is being continually improved, and also that the ground operated by No. 3 dredge does not now display the poverty of content which led to disappointment at first. The average yield of the ground worked by the three dredges was 16¼ oz. per yard, worth 12⅛d. The total cost per yard was 8·1d., made up as follows: dredging 3·43d., treatment 0·72d., duty 1·44d., administration 1·19d., dredge depreciation 0·72d., freight and selling charges 0·24d., London expenses and buildings depreciation 0·35d.

United States.—We refer in our editorial columns to anxiety caused to shareholders by the precarious conditions at the Alaska Treadwell group of mines. Similar disquietude has been experienced during the last few months among shareholders in the Alaska Gold Mines company, which owns the Gastineau property on the mainland, behind Juneau, on the opposite side of the Gastineau Channel to the mines of the Treadwell group. Our readers were fully informed with regard to the prospects of the Juneau mines by an article by Mr. Frederick Close in our issue of August 1914. Two companies are operating here on a big scale. One is the Alaska Juneau, which is under the control of the Alaska Treadwell group, and the other is the Alaska Gastineau, which is owned by the Alaska Gold Mines company, and is under the control of Hayden, Stone & Co. The lode on which these two companies are working is 120 ft. wide and the gold content is low. The distribution of the gold in shoots has been demonstrated, and the Alaska Juneau developed its property on the basis of selective mining. The controllers of the Gastineau property, acting on the advice of Mr. D. C. Jackling, decided to mine the whole lode without selection. Mr. Jackling estimated the reserve at 75,000,000 tons, giving an average yield of $1·75 per ton. The milling of 1,200,000 tons since the commencement of operations has shown the yield as being only $1·17 per ton. The monthly returns disclosed these disappointing results, and the share quotation in New York shrivelled rapidly. Hayden, Stone & Co. now issue a statement admitting that the scheme of development was based on a misconception of the mode of distribution of the gold in the lode, and indicating that in future a selective method of mining is to be adopted.

Colombia.—The interim report of the Frontino & Bolivia company for the first half of 1916 shows that the ore reserve has been increased considerably lately, and is now estimated at 42,200 tons averaging 20 dwt. gold per ton. During the period, 12,513 tons of ore was treated, for a return of gold worth £50,227, or 80s. 3d. per ton. The new cyanide plant has been put into commission and is giving satisfaction.

LABOUR PROBLEMS IN AFRICAN MINES—II.

By H. FOSTER BAIN.

Three systems of housing and feeding the natives at South African mines are in use: the closed compound, open compound, and native village. The relative advantages and disadvantages of these systems are considered, and details are given as to health and mortality. The third article of the series will discuss white labour.

I HAVE so far written at length, and friends on the Rand may think with over emphasis, upon the difficulties involved in the employment of natives in the mines. I have especially emphasized the little human differences, because we too often come to think of workmen as mere economic units. They are that, but even as such they are actuated by motives, and to one who knows and appeals to the correct motives they give a larger output of energy, just as the man who understands his car drives it better than the one who does not. The natives have their good points as well as bad. For one thing they are remarkably obedient. The whole training of the old native system was toward instant submission to an order, and even under the new dispensation this habit of obedience survives. Many of the natives are tricky, and will evade work if possible, but they generally do what they are told to the best of their ability. This docility of labour is a constant surprise to the visitor from other lands. The native submits so readily and so cheerfully to the demands made upon him that it is a wonder he has not been exploited more rather than less. The native, too, is by no means stupid. He does not accept the white man's estimate of relative values, but he is no clod. He is shrewd and sharp and has a keen insight into character. Life is a burden to the white boss who does not know his business and who attempts to bluff. The natives soon find his weak spots and trade upon them. Physically the boys are strong and alert. In certain directions, such as long-distance running, many show unusual ability and endurance. It follows that many make excellent trammers. For limited periods, at least, monotony does not worry a native. He can perform the same operation for hours at a time without apparent weariness, as witness the steady drumming at a native dance. It is this characteristic that makes them good hammer-boys on downholes, and it also suggests possibilities for the future in factory work, though anything of that sort lies far in the future.

Physically the natives have poor chests and they seem peculiarly subject to diseases of the lungs. The tables below show the mortality of new recruits and of repatriated natives for the year 1915 as recorded by the Witwatersrand Native Labour Association.

MORTALITY OF NEW RECRUITS.

Disease	Total
Pneumonia	13
Cerebro-spinal meningitis	9
Cirrhosis of liver	1
Appendicitis	1
Enteric fever	1
Pemphigus	1
Pericarditis	1
Pulmonary tuberculosis	1
Scurvy	1
Total	29

MORTALITY OF NATIVES RETURNED BY MINES.

Disease	East Coast	Mozambique	Quilimane	British Territory	Total
Silicosis	35	6	1	3	45
Tuberculosis of lungs	74	2	–	10	86
Tuberculosis, other	52	3	1	7	63
Pneumonia	6	–	–	–	6
Enteric	3	–	–	–	3
Bronchitis	1	–	–	–	1
Kidney disease	1	1	–	–	2
Malignant disease	6	–	–	–	6
Dysentery	1	–		–	1
Measles	1	–	–	1	2
Scurvy	1	–	–	–	1
Syphilis	1	1	–	–	2
Colitis	2	–	–	–	2
Meningitis	–	–	–	1	1
Pericarditis	–	–	–	1	1
Other	16	–	–	–	16
Total	200	13	2	23	238

Further light on the diseases of the natives is afforded by the following notes kindly supplied by Dr. Loesser of the Crown Mines. As the Crown Mines is the largest single employer of natives on the Rand, and its officers and medical staff take a most intelligent interest in these problems, these notes are especially significant.

HEALTH OF THE COLOURED LABOURERS ON THE CROWN MINES.

The efforts to preserve the health of the coloured mine labourer have developed parallel with the expansion of gold mining on the Rand into a great industry. The problem is beset with difficulties, principally because of the class of labour, which consists of the untutored semi-savage, without the most elementary understanding of hygienic considerations.

The directors of the Crown Mines, which employs over 15,000 coloured labourers, have always taken special interest in the question, not only on account of its economic importance, but because of its humanitarian aspect.

The success achieved in Panama stimulated the movement. There the death rate from disease among the coloured labourers of the Isthmian Canal Commission and the Panama Railroad Company was reduced from 45·52 per thousand per annum in 1906 to 6·94 in 1912. The death rate from all causes among the coloured labourers on the Rand was 80 per 1000 in 1903 and 19 in 1915.

As a result of the attention which has been given to the question of health on the Crown Mines, the mortality from disease has dropped from 28 per thousand per annum in 1910 to 14 in 1915. Moreover, the proportion of the complement of coloured labourers in hospital owing to sickness, which a few years ago approximated 2% on average, fell to 0·53% in 1915. Similarly, while in 1910, of the average number employed, the percentage in hospital owing to accident was over 2%, in 1915 it was only 0·84%. It must be remembered that all labourers unfit to work for any physical reason whatever are placed in hospital.

From the economic point of view, this reduction in the number of natives unable to work owing to sickness and accident, represents a saving of 37,786 working shifts in 1915, as compared with the previous best year, and 98,232 shifts as compared with the average conditions prevailing during the five years, 1910–1914, inclusive. Moreover, calculated at the death rate of the worst year (1911) in the history of the Crown Mines, there would have been 426 deaths from disease in 1915, while the actual number was 212. This saving of 214 lives represents part of the humanitarian aspect of the question. The relief of suffering owing to improved nursing facilities cannot be expressed in figures.

The lines on which improvement has taken place on the Crown Mines are as follow:

IMPROVED WORKING CONDITIONS.—Much improvement has been made in the direction of efficient ventilation, laying of dust, and the dispersion of noxious fumes. Great efforts are being made to prevent accidents. As tending in this direction it may be noted that £126,000 was expended at the Crown Mines in one year for sand-filling, timbering, and rock-walling. A 'safety-first' campaign receives active encouragement. Prompt and efficient attendance on the injured is provided by an elaborate first-aid organization.

IMPROVED SANITATION.—Water-borne sewerage has been introduced and improvement achieved in the direction of housing, general cleanliness, disposal of refuse and garbage, etc. To improved sanitation may be attributed the reduction in the incidence of and mortality from enteric fever, dysentery, and other diarrhœal diseases. Thus the incidence rate for enteric fever was 16·64 per thousand per annum in 1910 as against 2·87 in 1915, and the death rate from this disease 4·2 in 1910 as against only 0·73 in 1915. Similarly with regard to dysentery and other diarrhœal disease the incidence rate was 13·15 per thousand per annum in 1910 and rose to 20·06 in 1911, with a death rate of 1·07 and 1·44 respectively in these two years, and fell to an incidence rate of only 3 per thousand per annum in 1915 with a death rate of only 0·13. The main diseases for consideration, however, are pneumonia, tuberculosis, cerebro-spinal meningitis, and scurvy. The latter naturally falls under the heading of another line of progress, namely, improved feeding.

RATIONS.—The following is the minimum ration scale for native labourers:

ARTICLE	MINIMUM ALLOWANCE
Mealie meal (1)	20 oz. per day
Bread (2)	8 ,, ,,
Beans (dried) (3)	4 ,, ,,
Salt	½ ,, ,,
Meat	3 lb. per week
Pea nuts (4)	22 oz. ,,
Treacle (molasses, golden syrup) (5)	1 lb. ,,
Fresh vegetables (6)	2½ lb. ,,

(1) Exclusive of the mealie meal used in preparing marewu, the making of which should not be restricted.
(2) To be issued on each working day to all underground natives and to those surface workers who do not have access to the kitchen at midday.
(3) Must be properly cooked.
(4) May be replaced by a weekly allowance of 7 oz. of animal or vegetable fat (of good condition and served in a form palatable to natives), plus 22 oz. of dried beans.
(5) May be replaced by sugar.
(6) May be replaced by fresh or dried fruits.

An employer may make changes in the articles of diet, provided that in the opinion of the medical officer such changes do not reduce the physiological or calorific value of the diet as a whole.

The labourer has the opportunity of augmenting and varying this diet by the purchase of foodstuffs from eating houses in the vicinity of the compounds.

SCURVY is closely connected with the question of feeding, although in its manifestations on the Rand it often assumes an almost epidemic character. In the past it has been a serious factor. The incidence rate on the Crown Mines has been as high as 24·06, and the death rate as much as 2·68 per thousand per annum. In 1915 the incidence rate was reduced to 1·26, and there was not a single death from this disease.

IMPROVED MEDICAL SUPERVISION AND NURSING.—This is principally directed toward reducing the mortality from the diseases that most seriously affect the health of the coloured labourer on the Rand, pneumonia and phthisis.

PNEUMONIA, while always present on the Rand, now and then assumes epidemic pro-

A MATABELE VILLAGE.

portions, the cause of which has not yet been found. On the Crown Mines, while there has been little if any success in reducing the incidence of the disease (60% of the deaths from disease in 1915 were due to pneumonia), progress has been made in reducing the mortality by developing more efficient nursing of the sick. The South African aborigine is excessively susceptible to this disease, as he is to pulmonary phthisis. Experiments on a large scale have shown that by preventive inoculation the attack-rate of pneumonia is probably reduced by about 25% among the coloured mine labourers, but that such partial immunity only lasts for a short period. In view of this, preventive inoculation with a polyvalent pneumococcic vaccine is carried out in a routine manner on the Crown Mines, all native labourers being inoculated on arrival and reinoculated every four months.

PULMONARY PHTHISIS has claimed many victims among the native labourers in the past. In the worst year there was a death rate of 7 per thousand from this disease on the Crown Mines, and while in 1915 the death rate was only 1 per thousand, the incidence rate was still high, namely, 20 per thousand. By more careful medical inspection and repeated reinspection, efforts are being made to exclude and eliminate the physically unfit and to detect the disease in its early stages, which allows the removal of the invalid to conditions more suitable to recovery.

MINERS' PHTHISIS. — When a coloured labourer is found to be infected with this disease he must be compensated and repatriated. The figures suggest improvement. In 1914 the Crown Mines had to compensate 95 coloured labourers and in 1915 only 20 (with a larger complement). More careful and efficient medical examination tends to show that the coloured labourer is comparatively little susceptible to this occupational disease, probably owing to the fact that he only works intermittently, and that most cases of pulmonary phthisis in the native mine labourers are pure tuberculosis and not silicosis.

CEREBRO-SPINAL MENINGITIS prevails in an endemic form and claims a number of victims. In 1915 the incidence rate was 2·73 per 1000 per annum and the death rate 1·93, which shows that the case mortality is high.

I regret not having room for similar statements of results of interesting and careful records made by the medical officers of the other groups, all of whom are keenly alive to the importance of the subject, or for any adequate accounts of the hospitals and medical services maintained by the mines and labour organizations for the benefit of the natives. They are among the most interesting features of life in South Africa, and are well worthy of a whole book. The following brief statement was furnished me by Mr. P. K. Horner, general manager for the Union Minière du

Haut Katanga, and is interesting for comparison as it relates to work far to the north. The figures are for the year 1915. It will be noted that despite the differences in conditions the death rate is about the same as on the Rand, 20·3 per thousand as compared with 19. The fall in the rate at both places is the most encouraging factor in the situation. The mortality rate of natives employed by the Union Minière for the year 1915 works out at 20·3 per thousand of natives through the compounds, as against 47 per thousand for 1914. This reduction holds good for all races, as is shown by the following figures:

	1914	1915
	%	%
Rhodesian mortality	4·60	1·16
Nyassa (including Portuguese)	10·59	6·09
Congo	3·55	1·60

The causes of death among the natives were as follow:

Dysentery	61
Pneumonia	53
Typhoid fever	25
Scurvy	13
Accidents	7
Diarrhœa	5
Septicæmia	4
Syphilis of liver	2
Cerebro-spinal fever	2
Miliary tuberculosis	1
Phthisis	1
Pyæmia	1
Beri Beri	1
Endocarditis	1
Suicide	1
Cause unknown	10
Total	188

The system of feeding and caring for the natives employed upon the mines in Africa varies in the different districts and to a less extent among the mines in each. Pay always includes food and housing direct or indirect, and the law requires both close medical supervision and adequate hospital service. These have become such a matter of course that the law is not now necessary, nor is it often called to mind. The mining companies have learned thoroughly that not only is a well fed and well protected workman the best worker, but that a contented repatriate is the best recruiter. Whatever might be the temptation otherwise to neglect the natives or to economize in their food, the competition for labour and the cost of the neglect would prevent it. I am glad to say that these motives do not seem to enter largely into the minds of the men in charge. Instead they like the natives and are genuinely interested in them. If there be any criticism that may be fairly lodged in this direction it is rather in the form of a question whether at times too much rather than too little is not done for the boys. Whether in attempting to give them what seems to the white man obviously better conditions of living, something is not forced upon the black man which by reason of his past life and habits he is so unprepared to utilize that it becomes a danger to him.

There are two general systems of housing the natives. One is in compounds and the other in native villages. The first characterizes, though not to the entire exclusion of other systems, the Rand and the diamond mines; the other is the system adopted in Rhodesia and Katanga. There is a further difference in that the compounds of the diamond mines are necessarily closed, while those of the Rand are virtually open. There are also differences in the system of issuing food. On the Rand cooked rations are issued day by day from central kitchens. At the diamond mines the boys receive instead a cash allowance with which they buy as they please from the compound stores, doing their own cooking. In Rhodesia cooked or uncooked food is issued to the natives as the local manager thinks best. In Katanga the rations are given out uncooked three times per week and the men organize their own messes. The compounds on the Rand and at the diamond mines are great barracks, built usually of stone or brick with iron roofs. They are one storey high and usually surround a central court or patio. At a large mine there may be several such courts communicating, or the individual courts may be separated. There are gates at the corners or in the sides of the compound and police boys are on duty here at all hours. At the diamond mines the boys are never allowed to leave the compounds until their contract is expired. They go to and from the mines without going outside the walls, and they are necessarily under the strictest surveillance. On the Rand they go daily from the compound to their work and back, and may be given passes which permit visiting in the town or up and down the reef. They are checked in and out each day by a system of tickets, also in use elsewhere, the general principle being that the boy cannot draw rations except upon presentation of a ticket properly marked by his working boss showing that he has performed the day's labour. Sick boys are sent to the hospital and come under another regimen. It is generally true under the compound system that a boy must work or go to the hospital. The company must pay for five shifts per week even if the boys are not used, and Sunday work is exceptional throughout South Africa. The hours are short and in practice the boys on the Rand spend much of their time in the compounds or visiting up and down the reef. Out of work hours there is little effort to keep them close, except that there is a strict rule against any native being out after 9 p.m., an elaborate system of native police enforcing this rule.

The courts of the compounds are usually bare. There is a comfortable theory on the Rand that the native does not care for shade, and certainly he shows no great aversion to squatting or lying in the sun. Further north native quarters at the mines are frequently, if not generally, well shaded by trees and the natives seem to appreciate their presence. The interior courts usually contain a number of buildings such as kitchens, breweries, bath houses, laundries, first-aid huts, and such like. At all the mines provision is made at the shaft or in the compounds for baths for the natives, and a hot shower-bath at the close of work is the regular order of the day. In the mines few of the boys wear much clothing, and a blanket is the ordinary apparel while going to and from work. After the day's work and the bath, such clothing as the boy owns is put on and he is ready for the serious business of life, the evening meal. At the Lonely Reef mine in Rhodesia, where the shaft is some distance from the village, a change and a bath house is provided at the shaft mouth and each boy leaves his mine clothing in charge of a native keeper when he goes home. These details vary from mine to mine, but the daily bath is universal and seems to be much appreciated, while the change of clothing is common.

Laundries are provided at all the mines, where the boys may wash their own clothes if they are bachelor boys, or their women may do it for them where native villages replace compounds. The first-aid hut is not universal, but is common. The natives are not sensitive to pain, and are disposed to neglect small cuts and bruises. By placing dressing stations in charge of orderlies right at the mouth of the shaft or at the entrance to the compound, they are being brought to give proper attention to these minor hurts and so to avoid greater trouble. As the greater number of cuts are on the feet and legs, the manager at one Rhodesian mine constructed a sort of sheep-dip through which the boys were required to wade on returning from work, but this heroic method of meeting the situation has not become popular.

In the closed compounds the most interesting place is the store, where a surprising variety of food, clothing, and luxuries is kept for the boys. They by no means restrict their purchases to mealies and blankets. At the Premier mine an enterprising native bought a gramophone, cleared out a room, and gave a series of concerts at a 'tickey'—the South African name for 3d.—per head, to his own financial advantage and much general delight. Such business enterprises are not usual, for the South African native, while enjoying bargaining for its own sake, does not often have a keen business sense. One of the difficulties in running a compound store is to determine proper prices. There is no inducement to run the stores as profit-making enterprises, as all the worker's income is derived from the company itself, and his net wages are really determined by competition with mines where there are no such stores. To raise prices would therefore merely mean in the end higher wages. It is not good business, however, to sell at prices notably below those charged by stores outside the compound, as that gives the native an idea that all the outside stores are in the hands of cheats, and in a country where the white men are so completely in the minority as in South Africa it would be a grave public danger to allow such a notion to gain ground. The actual practice is to compromise, to sell at low prices, somewhat above cost, and to devote the profits to some form of benefit for the workmen. Prices of food and necessaries are made low so as to encourage good feeding. Luxuries are priced high, and in this as in many other matters the leaders of the diamond industry have set an excellent example in far seeing. At mines where the food is issued raw or is sold to the boys the latter organize their own messes, and cook over open fires in native style. In the native villages this work falls to the women, but in the compounds, where women are never allowed, it is customary for young boys to take their duties.

The minimum ration is fixed by the government, and it is generally exceeded. The standard Rand rations have already been quoted. It figures to about 4000 calories. The only criticism that can be made is that eating the same thing every day is terribly monotonous. It is doubtful though whether the native really objects to monotony and, while one has the instinctive feeling that it cannot be good for the boys to live on such uniform diet, actually the bad results feared do not materialize. If the Rand mines were allowed to raise their own food supplies in part, instead of being strictly forbidden even to keep gardens in the interest of truck farmers, it would be possible at the same expense to give the natives more variety. From time to time, when green vegetables are scarce, there are outbreaks of scurvy, but these are promptly brought under control. Actually there is more variety than called for by the official list. Thus at the Simmer & Jack I found the following ration in use, all the materials being bought on specification and regularly checked by analysis:

Meat	½ lb.
Mealie meal up to	2 "
Bread, made of wheat and mealie meal	¾ "
Vegetables, varying with the season	½ "
Sweet potatoes, once a week	
Green mealies as extra when in season	
Sugar, per week	1 "
Salt	*ad lib.*
Sweetened lime juice	"
Marewu	"
Kaffir beer, per week	3 quarts
Rice is added once a week to the mealies, and macaroni is cooked in the soups	
Fruit, oranges and peaches	Occasional
Beans are used occasionally as an extra	
Hot coffee, tea, or cocoa in rotation each morning	1 quart

Pea nuts are added to the ration at Knights Deep, and many of the mines use hot cocoa *ad lib.* as a means of fighting pneumonia. At the Lonely Reef mine in Rhodesia and at the Lubumbashi smelter in Katanga especially good results have followed its use.

The ration used in Rhodesia is closely similar to that on the Rand. At the Lonely Reef mine it is as below:

	Pounds
Mealie meal, sifted and cooked, per day	2
Meat, fresh issued Wednesdays and Saturdays, two rations in all, each	1¼
Pea nuts on Tuesdays	2
Fresh vegetables from mine garden and purchase, as available, including potatoes, onions, beans, carrots, cabbage, pumpkins, twice weekly, each ration	1¼
Cocoa, hot and sweetened, as the native comes off shift day or night, is also supplied.	

In Katanga, where rations are issued uncooked three times a week, the weekly allowance is as below:

	Pounds
Mealies	12
Fresh meat	2
Beans	2
Pea nuts or rice	2
Fresh vegetables	4
Salt and tobacco in small quantities and dried fish at intervals are added.	

The rations here are weighed out in advance and placed in small canvas bags, and issued to each man on presentation of the proper ticket.

When cooked food is issued it is all prepared by a special kitchen force. It is cooked by steam in great kettles, and the only exception is bread which is baked in ovens as usual. It is also customary in many compounds to issue uncooked meat on Sundays in order that the boys may roast or broil it over their open fires if they like. From time to time also the boys in a compound buy a goat, some sheep, or even a bullock, and give a barbecue followed by native dancing. This is a great event, and usually natives from other compounds are invited as guests. The mainstay of the natives' diet is 'mealies,' or what the Americans would call corn meal. This is boiled in water with a little salt and cooked until dry enough to be taken in the fingers in hunks or cakes. Virtually it is served *ad lib.*, though in theory a certain amount is allowed each boy. With the mealies is issued a piece of boiled meat and a cup of vegetable stew or thick soup. Food is issued twice per day. At some mines the main meal is in the morning so that the boys may go well fed to work, but the more common practice is to place the principal meal in the afternoon when the day's work is done. A common plan is for each boy to line up with his plate and cup and to pass along the side of the kitchen, receiving in turn the various elements of his meal. He is often, but by no means always, required to first wash his dishes, tanks of scalding water being placed where he must pass them before coming to the counters where the food is issued. Failure to present a clean plate requires a return to the washing tank before he can obtain his food. Having filled his plate and cup he joins a circle of brothers on the ground, around a fire, or in his quarters as most pleases him. Bread is usually issued in the morning and is intended to serve as a midday lunch underground, but in practice many of the boys eat it before or while going to the mine, on the general theory apparently that it is never wise to put off till tomorrow any pleasure that may be enjoyed today. Irregularity in eating hours does not seem to be a hardship to the native. Indeed it appeals to him as crowning evidence of the stupidity of a white man that he has to look at a watch to tell when to eat. For himself, and like a sensible fellow, he eats when he has food and is hungry. The power of the native to go long periods on little or no food is much greater than that of most white men.

The drink problem among the natives in the compounds is a serious one. Every effort is made to keep them from getting strong liquor, and yet it does filter in from time to time, with the usual result of a quarrel and some fighting. Where it is kept out the natives show great ingenuity in manufacturing it. Let them but obtain a can of syrup or sufficient sugar and they will ferment it into a rum that would seem strong to the most confirmed toper. The usual beer is Kaffir beer, which is a mild drink made from the grain of Kaffir corn and is widely used throughout South Africa. It is so universally available that it would only be possible to keep the natives from it by rigidly enforcing everywhere the closed compound system of the diamond mines. At most of the mines virtue has been made of a necessity, and breweries have been erected inside the mines for preparing Kaffir beer and marewu, the latter another mild native drink made by fermenting boiled mealies in water. These drinks are brewed under expert supervision, kept clean, pure, and low in alcohol, and are issued as part of the regular rations. At some mines the amount is limited, but at others it is given out *ad lib.*, except in any case of special abuse. Since marewu can be made by merely adding water to the cooked mealies and leaving it to ferment in the sunshine, it will be realized how entirely impossible it would be to keep the boys from some such drink. In the opinion of most medical men who have tried all plans, it is better to issue them drinks. One medical officer of wide experience reported that he had never seen any bad results from marewu drinking. 'Beer bursts' resulting from excessive drinking of Kaffir beer do occur, but the effervescence of spirits is temporary. And what would you? Shall the life of the workman be all drab and monotony? I have experience of mining camps in other lands where the principal excitement was when some workman got drunk and beat his wife. Taking a large view of the case, I am disposed to believe that the general pleasure and mental stimulus the camp received justified the act; and I more than suspect that the opportunity for a case of nerves was not always unwelcome to the woman involved. In the compounds at Johannesburg there are no women to beat, and there are thousands of men to whose ancestors for generations fighting has been the normal order and chief excitement in life. If under the stimulus of a mild native beer the members of the various tribes, recalling their former glories, go out to impress upon others their superiority, and as a result first-aid is in a few cases necessary, it should be remembered that all work would make Jack a dull boy. It should also be remembered that despite many temptations the natives in the compounds are so orderly that any disorder attracts attention far beyond its dues.

The sleeping quarters of the compounds consist of a series of rooms surrounding the courts. In each of these rooms from 30 to 60 boys are housed, the amount of air space being carefully regulated by law. The bunks are arranged around the walls and in part in tiers in the centre. Two and three bunks are superimposed vertically as on a steamer or in a cheap lodging house. In the newer compounds the bunks are made with an iron framework and a composition bed made of cement and asbestos. This gives a slab that is not as cold as stone but is equally vermin proof and equally easy to wash down. Most of the bunks consist of planks set in an iron framework. Usually the individual planks can be easily removed. If not, the whole board bottom can be taken out and dipped in scalding water or some vermin-killing solution from time to time. Walls, floor, and roof are so

THE KAMBOVE COMPOUND.

built as to be easily washed and both walls and roof are periodically coated with whitewash, while at the same time the floor is scrubbed and the beds dipped. There are no mattresses, and such bedding as the boys have they must furnish. Usually they own a blanket or two, but they are not accustomed to much bedding. Each bunk is generally built longer than is necessary for sleeping and at its head or foot the boy stores his possessions, in a tin trunk, if possible, the latter being the most prized of pieces of personal property and among the first things purchased. Some of the boys hang cloth entirely around their bunks and so convert them into cubicles that become the exclusive space of the occupant. But they are by inheritance and training communists, and have little desire for individual holdings or property. There are no windows, but an always open door and a free circulation of air up to and under the roof, gives good ventilation. Heat is provided by wood or coal fires in open braziers, usually a much punctured sheet iron pot or can of some sort. Surplus property, such as bicycles, is hung up to the beams overhead, but much of it lies around loose, and general report is to the effect that respect for each others rights of property is general and petty thieving uncommon.

Such, most sketchily portrayed, is the general life of the natives in the compounds. There is considerable difference in the character of the buildings, old and new, but in the main the system is the same. It is well thought out, and enormous amounts of energy and money are expended in the effort to give the native clean, wholesome surroundings, and to keep him physically fit, but there is no escape from the fundamental fact that compound life is unnatural to the native. It takes him away from home ties and his family, it makes him a mere animated number, and his life is little different, for all the good intent of his employers, from that of a prisoner. One must, however, not be over hasty as to conclusions, for being a prisoner may not mean to the native what it does to us, and there is no question that, despite the fact that he is for his term of service an actual prisoner at the diamond mines while he has much more freedom on the Rand, he flocks to the former and must be recruited for the latter. Whether the opportunity to cook his own food in his own way, the larger amount of work above ground, the bonus paid for diamonds found, or mere habit be the determining factor, it remains true that the native prefers work at Kimberley and the Premier to that on the Rand.

In Rhodesia and Katanga the boys are generally housed in native villages built at the mines. It will be recalled that on the grounds of health alone this system was recommended for the Rand mines by Colonel Gorgas when he studied the miners' phthisis problem for the Chamber of Mines. The whole scheme of living in such a village is much more like that to which natives have been previously accustomed, and transition from kraal to mine requires much less break with past traditions and habits. This system has not been favoured on the Rand, partly because of the disinclination of the whites to have big native villages grow up in the outskirts of their own towns, and partly because of the greater expense. A first step in the direction of the village system is, however, being made now by the New Modder, and to one who comes from the outside and so sees from a detached point of view, even if by chance he does not envisage the whole of the matter, the native village plan seems not only the better but the inevitable final method. It is true that there are many objections to enlarging the heathen population around the mines, and it is also true that the better and steadier natives would not want to bring their women to the Rand so long as moral conditions remain as they are. It is, however, to be remembered that we are rarely able to eat our cake and still possess it, and that many times we can only make a choice of evils. I have already pointed out the great increase in cost, loss of efficiency, and accident rate due to the constant flux of labour. The system of recruiting and repatriating boys was only built up because there was no sufficient local supply, the high veldt not being densely populated when the white men came to it. It is true that the number of volunteers and of reinlistments is growing at a comforting rate, but the whole system is at best expensive and unsatisfactory. It cannot compare with the advantages of a permanent population of natives accustomed to mine work and without ties elsewhere or other methods of living, which might naturally be expected to result from the village system. It is also a question as to how long other parts of South Africa will permit recruiters to take boys away to the mines. It must be remembered that agriculture and other industries flourish in the regions from which most of the boys come, and as they expand there will be more home demand for labour. Already there is serious protest from the farmers in a few communities, as they cannot, or think they cannot, pay wages that compete with those paid by the mines. In South Africa, as in many another country, political control rests with the farmers, and it is by no means certain that they will continue to acquiesce in the steady draining away of local labour by the mines regardless of their own seasonal wants. For the native himself, also, it would seem that specialization of labour would ultimately prove beneficial, as it has to the white man. Part farmer, part herdsman, part miner, means an inefficient labourer at all three callings, and inefficiency in the long run exacts its penalties. In the past, and while the mines were getting phthisis under control, it has been an advantage to the boys that they did not work long at one time in the mines. The recurrent life in the kraals and under conditions natural to them renewed their vitality and resistance. The necessity of this is now much less, and we may look forward confidently to the time when phthisis will be among the things that used to be. As to the supposed danger of having native villages around the mines, it is to be remembered that the large number of native boys now at the mines constitutes a possible danger. They may not always be as docile as now, and inherently the thousands of men in the compounds, away from their women and separated from such restraints as home ties furnish, are packed with social dynamite. It might be safer to build on their old organization of life than to try too abruptly to change it.

As for the greater cost, it is not certain but that this is partly illusive and partly unnecessary. It is naturally cheaper to house 30 men in one brick iron-roofed room with iron beds, than to build seven or eight detached cottages of equally permanent type for them. It also takes more room. Fortunately the Rand mines, and especially those still to be opened, which will be in the Far East and as deep deeps, need not restrict themselves as to surface occupied. If there be any sufficient advantage in native villages, there is plenty of room at the new mines and even at most of the old ones. The extra cost of spreading the community out is not so important in a native village as in a white man's city, as roads, water supply, sanitation, and communications are all simpler problems. It is also a question whether it is wise to build so elaborately as is becoming the fashion. It is very satisfying to the white man, but it is not so certain that the native either appreciates or benefits by it. The kraals in South Africa are almost universally made by driving a circular row of stakes, weaving them together with vines and bark, daubing the whole with mud and setting on the top a thatched roof woven on a stick and twig frame. The hut protects from the rain, the wind, and to some extent from the cold. It has been evolved out of the materials at hand in answer to the native's needs, and it is a type that shows distinct possibilities of evolution to something better. In the Katanga and Rhodesia many of the villages at the mines are of this type. At Wankie both brick houses with iron roofs and native huts are used. At the Falcon mine brick huts as well as the native 'wattle and daub' affair are in use. Here the brick huts cost £6, house 6 boys, and last indefinitely. The mud huts are cheaper, but require about 10s. repairs per year. At the Lonely mine round brick huts are furnished for the unmarried boys, a maximum of 6 to a hut, and mud huts for the married men. The brick huts cost £14 12s. Particulars are as follows: Inside diameter, 16 ft. 6 in.; height to thatch, 6 ft. 4 in.; Kimberley brick walls, wooden swinging door; distance between individual huts, 18 ft.; distance between main rows, 25 ft.; total cost of 128 huts, £1869. The detailed items of cost were:

	£	s.	d.
Stores	194	8	8
Native wages	170	0	6
White wages	260	15	2
Compound expenses	142	3	6
Shops	74	2	6
Contractors	1027	10	0
	£1869	0	4

At the Falcon the natives in the mud huts have seemed to have better health records, but at the Globe & Phœnix it is reported that substituting brick huts for the native mud structures was coincident with a marked betterment in health conditions. Health records depend on so many things and the figures I secured were so incomplete and in part so contradictory, that I became convinced that careful study would be necessary to show any special superiority of either type of house.

Where the village system obtains it is customary to invite the men to bring their families with them and to supply a limited ration to each woman. The latter further supplements the family income by acting as cook for some mess of unmarried boys, while any children old enough are given part-time employment in cleaning the camp. Where the 'wattle and daub' huts are used, the material and a site is provided for each family or each group of four or six boys, and they build their own houses. When they leave they are permitted to sell the structure to any new comer who may prefer purchasing to building. At the Katanga mines the huts are built on an earth platform raised about six inches above the ground so as to protect them from the flood of water which after a heavy rain flows through the village and cleans it out. The village at Lubumbashi is shown herewith. The huts at Kambove are square, 3 metres to each side, and are set in groups of 15 with 5 metres space between. Between the blocks of huts are streets 10 metres wide, and around the whole village and between it and the protecting high wire fence is an open 10 metre space. The latrines are in the rear of the village, but within the fence. This plan, with 4 boys to a hut, would provide for housing 310 boys per acre, but owing to the number of married men, each of whom is assigned a hut for his family, the actual housing is about 160 workmen per acre. The Katanga villages are in a wooded country, and there are trees in the compounds. The women collect fire-wood from the surrounding forest, but water is brought to various parts of the village and made available by means of public taps. The villages are regularly policed and inspected, and when one family moves out of a hut it is thoroughly renovated before a newcomer is allowed to take possession. In particular the earth of the floor is dug up, soaked in scalding water, relaid, and the interior replastered, especially where wall and floor join, to prevent the entrance of vermin. While this is being done, the waiting family lives in a temporary grass hut in a field. The 'wattle and daub' huts cost about £6, and the thatch needs renewal about every three years.

At the Lonely mine in Rhodesia, in the married quarters the 248 pole and mud huts are 10 ft. inside diameter and 5 ft. wall height. They are set 15 ft. apart. Most of the trees were unfortunately cut long ago. Wood as well as water is provided, and the arrangement of the huts is different in detail, but the scheme is essentially the same as that adopted farther north. In such a village there is much of interest both to the native and the visitor. The groups around the open fires, cooking, superintending the bath of a child, or just gossiping in neighbourly fashion, give a home-like atmosphere to the place. House raisings are social functions, for the roof framework is built on the ground and then hoisted on the waiting walls by community effort, with much expenditure of muscular energy and language, while the master of the house bustles around swelled with importance and the wife waits timidly the rearing of the family roof. After "the tumult and the shouting dies," she and her husband sew on the thatch together, and who can doubt that such a home means more to the workman than a bare bunk in even the most modern and sanitary compound? Many of the families become ambitious and build additional rooms, closed passages, and other adjuncts to the simple hut, so as to set the family possessions above those of the common lot. Each must supply his own furniture, and I noticed one woman who, being possessed of a small sewing machine, sat with it conspicuously just inside the door to be seen and envied by all the other women in the village. In the long run the natives of Africa can only be brought to regular work by increasing their wants, or those of their wives, sisters, and other women folk, so that the significance of the sewing machine must not be overlooked.

On the whole these native villages make a much pleasanter impression on the visitor than do even the best compounds. One gathers that to the family a sojourn in such a village is much the same as a trip to the seashore or the mountains to an ordinary town worker at home. The percentage of volunteers under the village system is good, and a nucleus of permanent workers is being formed. I should judge that moral conditions in them were not ideal, but neither notably better or markedly worse than in the kraals from which the natives come, while experienced students of the natives in the country from which they are recruited and to which they return assert that the moral damage of life in a compound is too great to be compensated by such intellectual quickening as he receives.

With this I must leave the native labour problem. If what I have said seems a bit general and indefinite, it may be well to remember that it is only in such terms that one can talk who touches even the outer edges of so large a problem as the future of the natives of South Africa, and nothing less is involved in studying the labour supply of the mines. It is a problem in which many factors are unknown, and no single solution yet offered is clearly correct. I confess to a partiality for evolution rather than revolution, and so would build upon the system the natives themselves developed rather than a makeshift of periodic migrations and barracks. Training a part of the men to work permanently in the mines will undoubtedly decrease costs, lighten the cares of the managers, and make for health and efficiency. Rewarding the latter by a better distribution of the profits of labour will naturally follow and will build, I believe, a sounder basis for industry than the plan now being pursued.

DEEP-LEAD AND DRIFT MINING

By M. T. TAYLOR.

An account of the methods employed in developing and mining auriferous deep-leads in Victoria. The gold gravel is covered by an overburden several hundreds of feet thick, and it is full of water, so that mining and pumping operations are costly.

*THE mining of auriferous deep-leads in Victoria presents a difficult problem owing not so much to their depth as to the immense amounts of water found in them. Though covered with hundreds of feet of overburden the ancient river beds preserve much of their characteristics as reservoirs and water-channels. The conditions were against economical work in most cases. With modern power and pumping plant many hundreds of miles of deep-leads might nowadays be treated profitably.

The nature of the strata may be exemplified by the following bore at Moorlort:

Strata	Thickness ft.	in.	Depth at which strata struck ft.	in.
Surface clay	13	0	0	0
Basalt	127	0	13	0
Clay	32	0	140	0
Basalt	76	0	172	0
Clay	22	0	249	0
Drift	126	0	271	0
Gravel	3	0	397	0
Clay	1	6	400	0
Drift	6	6	401	0
Gravel	7	6	409	0
Auriferous wash	15	6	416	0
Bedrock: Sandstone, quartz leaders, green slate	—		432	0

In Fig. 1, on the next page, I give a section across the Moorlort lead at the Loddon Valley Goldfields mine, showing the strata and the method of mining the deep leads. It should be parenthetically remarked that the levels at 389 ft., 410 ft., and 454 ft. were driven by the old Victorian Gold Estates Co., and were not at sufficient depth to cross under the lead, thus necessitating the sinking of the Keystone shaft and the driving of the 500 ft. level. Had boring been previously done, all this work would have been obviated.

POWER.—The particulars, given in the next column, of the plant at the Loddon Valley Goldfields mine will give an idea of the power required at a modern deep-lead mine.

MINING.—One of the most important factors to be taken into consideration before commencing mining operations is the choice of a suitable site for the shaft. Care should be taken wherever possible that the surface is sufficiently solid to carry heavy mining machinery and also that the strata to be passed through contain the minimum amount of drift. Therefore, before any mining operations are undertaken, the initial work should be the putting down of a line of bore-holes across the lead, near what appears to be the most favourable site. When it has been proved by boring that the site chosen is suitable, it is not wise to sink on the site of the bore-hole, for if any drift has been passed through, it will be found that boring operations have considerably disturbed the drift strata and will, in consequence, make the work of shaft-sinking more difficult and hazardous. Having fixed the site for the shaft, the next problem to decide is the position at which the levels should be opened. There are usually two, the wash and the main reef level, and the latter is, as a rule, 50 ft. below the

POWER AT THE LODDON VALLEY GOLDFIELDS MINE

No. 1 PLANT	Horse power
2 sets 26 in. Cornish plunger lifts (460 ft. each).	—
3 high-pressure steel Galloway boilers	—
Steam drilling machine	—
Lathe	—
Pumping engine	900
Winding engine	70
Compressor	35
Puddler engine	70
Root blower	30
Air pump	20
Dynamo	6
Machine shop	8
Feed pump	8
Capstan	30
Total	1177
AUXILIARY PLANT	
1 set 22 in. Cornish plunger lifts (460 ft.)	—
4 multi-tubular boilers	—
Beam pumping engine	270
Cameron air and circulating pump	16
Tangye feed pump	8
Total	294
KEYSTONE PLANT	
2 sets 26 in. Cornish plunger lifts (460 ft. each)	—
Pumping engine	900
Winding engine	70
Capstan engine	30
Compressor	35
Root blower	20
Dynamo	6
Air pump	30
Circulating pump	8
Sawmill engine	12
Feed pumps (2)	16
Total	1127
Total of all Plants	2598

* From a paper read before the Cornish Institute of Engineers on May 27, 1916.

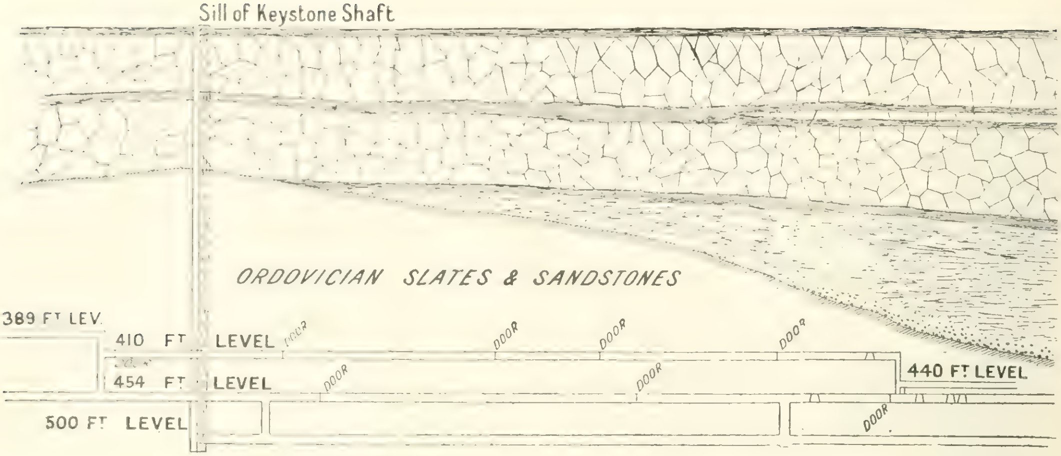


FIG. 1. VERTICAL SECTION THROUGH THE MOORLORT LEAD,

wash level. The only correct way to determine the point of opening is by putting down a line of bore-holes right across the lead to ascertain its depth, width, position, and character. Once this information is obtained the future work may be laid out in a systematic and economical manner; in fact, this boring should be the initial work and one of the cardinal points for guiding future operations. Thousands of pounds have been thrown away by companies failing to comply with these considerations.

SHAFT - SINKING. — Many systems are adopted in sinking through these drifts. Freezing has been tried with some success. On the Poseidon lead at Tarngulla, a shaft was successfully sunk by this method, but at the Ascot lead it proved a failure. It was stated at the time that the current of water flowing through the drift prevented freezing operations. Personally, I think it was on account of the freezing machinery being unsuitable.

Another method is the air-lock system. Two air-tight doors are placed in the shaft some distance above the drift, allowing sufficient distance between them to make room for the bucket to pass through. By the use of these two doors the air pressure is kept fairly constant, and, as the bucket ascends from below, the bottom door opens and the top door remains closed until the bucket is above the lower door, when the bottom door closes and the top door opens, and *vice versa* on the return journey. This method has many drawbacks and has a very injurious effect on the health of the men employed, and the shift worked is usually very short, varying from one to two hours per day.

Iron boxes with movable sides and ends have been successfully used. These are forced down through the drifts with high-pressure hydraulic jacks, the sections having cutting edges on the bottom (see Fig. 2). These boxes vary in depth from 4 to 6 ft., and are of sufficient size to allow for the timbering being placed inside. Strong angle or channel irons are bolted on the end and side sections to stiffen the plates, and are also placed in a position where the force of the hydraulic jacks can be applied when driving down the sections. The timber is placed in position as the box des-

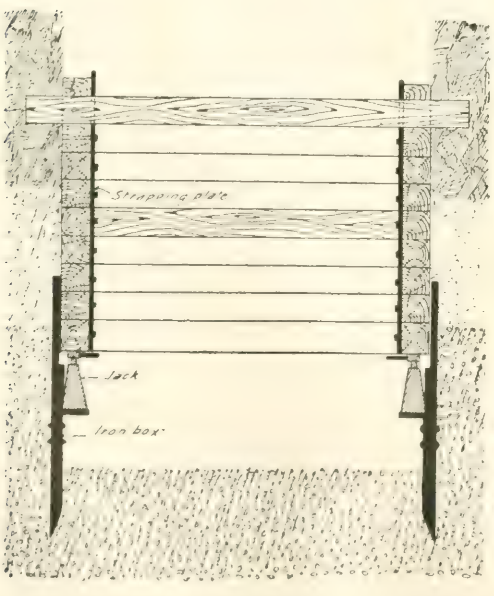
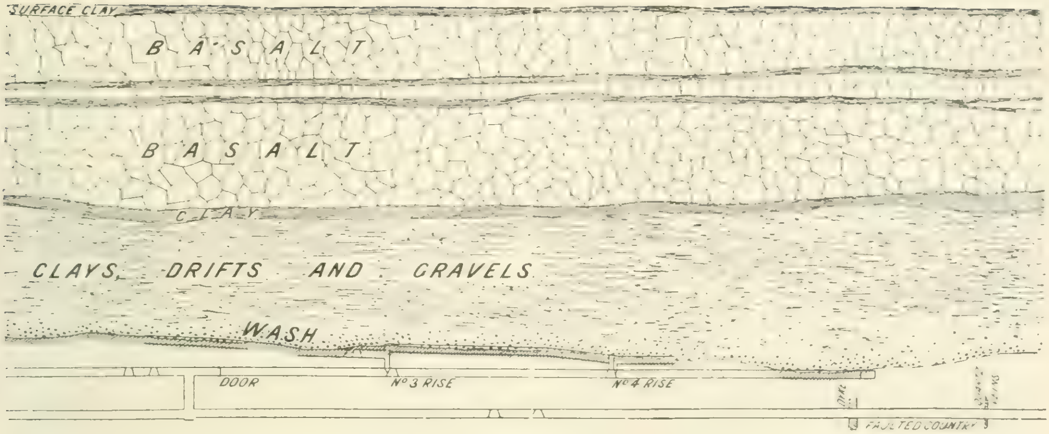


FIG. 2. SHAFT-SINKING THROUGH DRIFT BY THE IRON-BOX METHOD.



WORKED BY THE LODDON VALLEY GOLDFIELDS COMPANY.

cends, the top portion of the plates or sections always being above and behind the bottom set of timber.

A method of spiling has been adopted with success. A chamber is cut out immediately above the drift and a rectangular frame-set the size of the shaft is placed in its proper position (see Fig. 3). Pointed laths, or planking, are driven close together outside and around this frame-set and a suitable tailing-piece is placed to guide the course of the laths and to prevent the drift from forcing them out of line into the shaft. The length and thickness of the laths are governed by the conditions prevailing, but they are usually from 4 to 6 ft. in length and from 2 to 3 in. in thickness. An iron shoe is placed on the top of the laths to prevent the top from burring when being driven. When the laths or planks have been driven, say 2 ft. below the set through the drift, the material inside is removed and a false frame-set is fixed in position, securely hung by bolts from the main set. This allows the laths to be driven another 2 ft., when the next main set can be placed in position after again removing the drift inside the point of the laths. Care should be taken to pitch the laths at a sufficient angle outward so that ample room is left to place a bridge-piece between the laths and the bottom main set, and so that the next run can be pitched off without inconvenience. The process can be repeated until the drift strata have been passed through. Care should be exercised to thoroughly secure the first main set above the drift strata, as the whole of the remaining timbering may have to be hung from this point. Whatever method is adopted in sinking through drifts, one of the most important points to consider is to see that, as far as possible, the hydrostatic grade of the water at the point of operations is as flat as possible, otherwise, if there is a high water head or pressure around the shaft, there is danger of it forcing the drift up through the bottom of the shaft; and, if this takes place, the chance of successfully getting through is reduced to a minimum.

PLATS.—The next important point is the opening of the plats at the wash level. It is always best to get well under the wash before

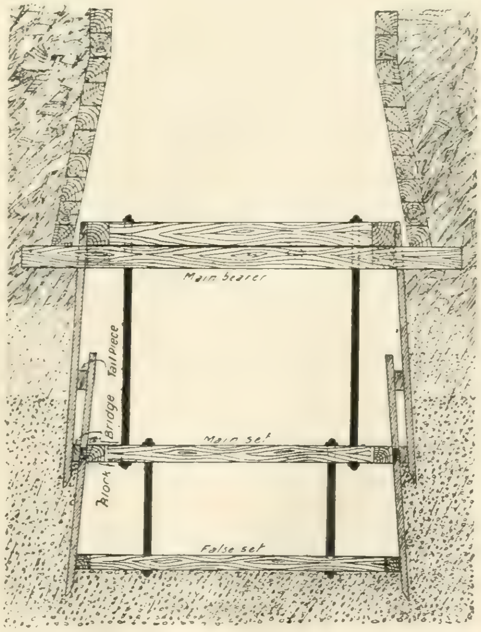


FIG. 3. SPILING THROUGH DRIFT, END LATHS REMOVED.

putting in the opening-out set, the distance being governed by the conditions prevailing. The shaft timber should be thrown back when sinking to receive this set, the reason being that most of the plats are from 10 to 12 ft. high and from 12 to 20 ft. in width, so that quite a large opening must necessarily be excavated in carrying out the work of placing the plat timbers, and, should a burst of drift occur, some difficulty will be experienced in overcoming it. At times a small drive* is driven from 50 to 100 ft. off the plat opening and then a full-sized drive is driven over the top and, from the inside, back toward the shaft. Another method is to drive the same distance off the plat as given above, taking half the width of the plat, and then commencing from the inside to work back toward the shaft, full sized timber being placed in position during this operation.

CROSS-CUTTING* AND BORING.—When a shaft has been sunk, say, from 500 to 1000 ft. from the edge of the lead, often no wash drives are driven off the main shaft, but a main-reef drive is carried out from the shaft in the bedrock at a depth of from 40 to 50 ft. below the deepest point of the lead. This is usually carried across the full width of the lead, and bores are put up as close to the face as possible to drain the water and indicate the distance the wash is above the back of the cross-cut. This also acts as a safeguard and prevents the cross-cut being unexpectedly driven into a portion of the lead that has become scoured and deepened, thus creating a position dangerous both to the men and the mine. The main-reef drives are carried along as near the centre of the lead as possible, as it is necessary to convey all the wash mined above to various chutes along its course for transport to the shaft. By this means it will allow the wash broken on each side of the main-reef drive being trammed the minimum distance. When the main-reef cross-cut has been completed, drives are started up and down the lead, and when extended a sufficient distance, cross-cuts may be again started with boring operations as before. When these are completed, the area of lead between the main cross-cut and the second cross-cut should become quickly drained.

The height of the water above the bedrock is determined by closing the main valve on the bore tubing and by boring a small hole in the portion of the tubing projecting below the top of the drive, to which a small pipe is tapped with valve attached, and the pressure is registered by affixing an ordinary water pressure gauge. The height of the wash above the drive or cross-cut is known and recorded when boring, and by using the pressure tables given on on the opposite page, a simple calculation will give the height of the water standing above the bedrock.

The following is an example of the method of using the tables: In the tables take a pressure on the gauge of 40 lb. This represents a height of water above the pressure gauge of 92 ft. As the bedrock is 40 ft., which represents 17·3 lb., this figure deducted from 40 lb. will leave 22·7 lb., so that 22·7 lb. will represent approximately 51 ft. of water standing above the bedrock.

It does not follow because very little water is coming away from the bore-hole that the wash above can be considered drained, for often the perforated portion which projects above the bedrock into the wash becomes choked or corroded, thus preventing the water from coming through, but, by the use of a pressure-gauge, a fairly reliable estimate can be made. When speaking of draining deep leads, it is not meant that the whole of the water in that particular lead has been taken out, but only that portion, or area, between the cross-cuts. The portion up and down the leads outside of the cross-cuts continues to yield water, and the longer the draining operations have been in progress, the flatter will become the hydrostatic grade. That is to say, if driving is started up and down the lead from the outside cross-cut, it will be found that the pressure registered on each bore is becoming higher as the work advances, and that, if the drives were extended a sufficient distance, the pressure registered would be approximately as great as when the lead was first tapped, although the area of wash between the outer cross-cuts would be sufficiently dry to operate on. This may be accounted for by the capillary attraction of the sands and drifts holding the water in suspension. Another fact noticed at the Loddon Valley Goldfields was that, after the water had drained below the top of the perforated tubing on the initial bore-holes put out from the cross-cut, a strong vacuum must have been created in the drifts above, causing a great current of air to rush up through the tubing to replace the water.

The method adopted for conducting boring operations from the cross-cuts and drives through the bedrock into the wash and drifts above is as follows: A frame is made by bolt-

* The term 'cross-cuts' in deep-lead mining means those drifts that are driven across the lead, and the 'drives' those that are driven with or along the course of the lead.

Tables for Calculating Water-Pressures.

TABLE I. *Unit:*—A column of water having an area of one square inch and a height of 12 inches, weighing 0·434 lb.

Height of water in feet	Weight in pounds	Height of water in feet	Weight in pounds	Height of water in feet	Weight in pounds
$\frac{1}{4}$	0·11	38	16·5	77	33·4
$\frac{1}{2}$	0·22	39	16·9	78	33·8
1	0·43	40	17·3	79	34·2
2	0·87	41	17·4	80	34·6
3	1·3	42	18·2	81	35·1
4	1·7	43	18·6	82	35·6
5	2·17	44	19·1	83	36·0
6	2·6	45	19·5	84	36·4
7	3·0	46	20·0	85	36·8
8	3·47	47	20·4	86	37·2
9	3·6	48	20·8	87	37·6
10	4·3	49	21·2	88	38·1
11	4·8	50	21·7	89	38·5
12	5·2	51	22·1	90	39·0
13	5·6	52	22·5	91	39·4
14	6·0	53	22·9	92	39·8
15	6·5	54	23·4	93	40·2
16	7·0	55	23·8	94	40·7
17	7·4	56	24·3	95	41·1
18	7·7	57	24·7	96	41·6
19	8·2	58	25·2	97	42·0
20	8·7	59	25·6	98	42·5
21	9·1	60	26·0	99	42·9
22	9·5	61	26·4	100	43·3
23	10·0	62	26·9	102	44·2
24	10·4	63	27·3	104	45·1
25	10·8	64	27·8	106	46·3
26	11·3	65	28·2	108	46·1
27	11·7	66	28·6	110	47·7
28	12·2	67	29·0	112	48·6
29	12·6	68	29·5	114	49·4
30	13·0	69	30·0	116	50·2
31	13·4	70	30·4	118	51·1
32	13·9	71	30·8	120	52·0
33	14·3	72	31·2	130	56·4
34	14·7	73	31·6	140	60·8
35	15·2	74	32·1	160	68·8
36	15·6	75	32·6	180	78·0
37	16·0	76	33·0	200	86·6

TABLE II. *Unit:* One pound weight of water = A column of water having an area of one square inch and a height of 27$\frac{5}{8}$ in. or nearly 2·3 ft.

Pounds	Height in feet	Pounds	Height in feet	Pounds	Height in feet
$\frac{1}{4}$	0·57	33	75·9	67	154·1
$\frac{1}{2}$	1·15	34	78·2	68	156·4
1	2·3	35	80·5	69	159·7
2	4·6	36	82·8	70	161·0
3	6·9	37	85·1	71	163·3
4	9·2	38	87·4	72	165·6
5	11·5	39	89·7	73	167·9
6	13·8	40	92·0	74	170·2
7	16·1	41	94·3	75	172·3
8	18·4	42	96·6	76	174·8
9	20·7	43	98·9	77	177·1
10	23·0	44	101·2	78	179·4
11	25·3	45	103·5	79	181·7
12	27·6	46	105·8	80	184·0
13	29·9	47	108·1	81	186·3
14	32·2	48	110·4	82	188·6
15	34·5	49	112·7	83	190·9
16	36·8	50	115·0	84	198·2
17	39·1	51	117·3	85	195·5
18	41·4	52	119·6	86	197·8
19	43·7	53	121·9	87	200·1
20	46·0	54	124·2	88	202·4
21	48·3	55	126·5	89	204·7
22	50·6	56	128·8	90	207·0
23	52·9	57	131·1	91	209·3
24	55·2	58	133·4	92	211·6
25	57·7	59	135·7	93	213·9
26	59·8	60	138·0	94	216·2
27	62·1	61	140·3	95	218·5
28	64·4	62	142·6	96	220·8
29	66·7	63	144·9	97	223·1
30	69·0	64	147·2	98	225·4
31	71·3	65	149·5	99	227·7
32	73·6	66	151·8	100	230·0

ing two 8 by 2 in. planks together with a 3 in. block to act as a distance piece placed between both ends. Holes of 1$\frac{1}{4}$ in. diameter are bored 1 ft. apart, through both planks, and into these holes a fulcrum bolt is placed on which the ratchet lever is worked. On the end of the lever a shackle containing a swivel bolt is attached. The top end of this bolt is cupped shaped and screwed to receive the bottom end of the boring rods. Four arms radiate from this bolt and are used as levers to turn the boring rods. (See Fig. 4 on the next page). Generally, three men are employed in the work of boring, two using the lever and the third turning the boring rods. With a distance of about 18 in. between the end of the lever to which the boring rods are attached, and the fulcrum bolt in the frame, which is about 8 ft. in length, the men on the lever are able to strike a very forcible blow, and in ordinary ground, can put up a bore very quickly. The size of the boring bit usually coincides with the outside diameter of the tubing used, which is generally 3$\frac{1}{2}$ in. steam piping, cut in 3 ft. sections, and screwed and socketed with a square thread, no coupling being used. About 12 ft. of the first sections are perforated with $\frac{7}{8}$ in. holes, drilled about 1 in. apart all round. The first section has a cutting edge and this is forced up 12 ft. above where the water was first tapped. Most of the boring through the bedrock is carried up to as near the bottom of the wash as possible before the tubing is placed in position, the remaining portion, unbored, being completed through the tubing and the latter forced up into position with hydraulic or screw jacks. A slot valve-piece is fixed to the bottom section of the tubing and can be opened or closed at will during boring operations.

RISING.—The work of boring operations

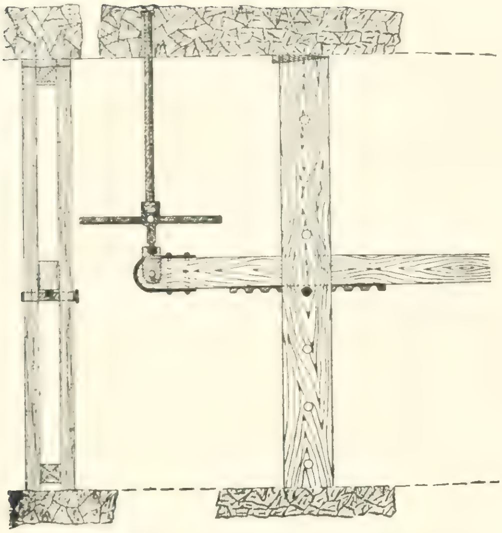


FIG. 4. METHOD OF BORING FOR DRAINAGE PURPOSES.

being completed, the next step is the putting up of a rise and opening out in the wash. The first step is to locate an elevated or raised portion of the bedrock in the lead. This can be easily done if the height of the bedrock and a record of the boring has been kept. Until such time as one is fairly conversant with the character of the wash and drifts, it is not wise to start rising direct from the drives or cross-cut; but a drift should be carried at right angles for a sufficient distance to allow of a flood gate being placed in position as a safeguard in case any mistake occurs in rising. This work is often done during initial boring operations. The reason for locating a high position in the bedrock is that it is better not to rise direct into the wash but to get as close as possible and open out beneath, and then to tap the wash when driving, or cross-cutting. By adopting this means there is far better control and, should any dangerous conditions arise, one is in a position to combat them more successfully. A two-compartment rise is usually put up, one being the wash chute and the other the ladder-way through which all timber required is hauled up and ventilating air-pipes and the down-flow water launders are carried. If the wash material is at all of a cementy nature the chutes or rises are made bell-mouthed. By this means there is less likelihood of their hanging up. Very often, in rising through the bedrock, the ground passed through is of a soft and loose nature, necessitating the use of head boards (see Figs. 5 and 6), this class of work always requiring competent and skilled miners. The size of the rise is usually 8 by 5 ft. and it is close-timbered, except at every 6 ft., where a 2 in. chock is placed between the sets, allowing room for cross-bearers to hold planking for staging purposes. The head boards are usually 8 by 2 in. planks, and are supported against the back of the rise by short props, or stulls, placed on foot pieces outside the rise timber. Near the top of the rise, the timber is always thrown back to receive the opening-out sets. When the work of rising has been completed, the pilot wash drive is driven as near as possible above the main-reef drives; or, in many cases, it is driven ahead of the reef drives, when the latter would be driven immediately under. From this leading wash-drive, cross-cuts at right angles, and at intervals of from 150 to 300 ft., are extended on each side until the side of the channel has been located. These act as a medium for drainage, and also prove the direction of the lead. Usually the distance between these cross-cuts is 300 ft. Then cut-

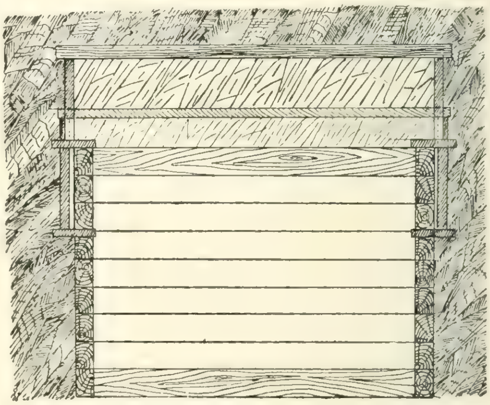


FIG. 5. METHOD OF RISING WITH BACKING BOARDS.
SECTION THROUGH END OF RISE.

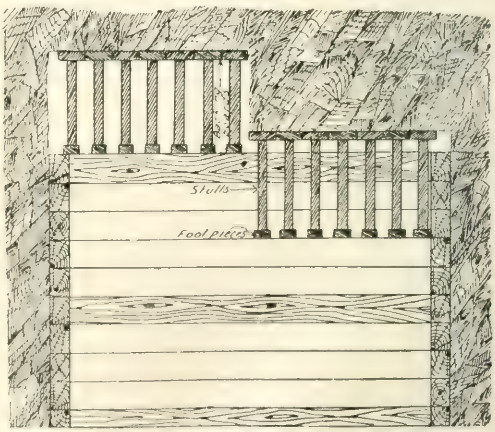


FIG. 6. METHOD OF RISING WITH BACKING BOARDS.
SECTION THROUGH SIDE OF RISE.

ting-up drives on the course of the lead are driven at right angles to the drainage drives 120 to 150 ft. apart, connecting with the cross-cuts off the pilot drives along the lead. Small cross-cuts, usually called truck roads, are then driven at right angles, the distance between them being according to the condition of the wash. If it is panelling ground, the distance between them would be 32 ft., and if it is blocking ground, the distance would be 40 ft., so that from each truck road a panelling strip would take 16 ft. each side and a blocking strip would extend to 20 ft. from each side. By this means the whole of the ground between the truck road would be excavated.

PANELLING.—There are two methods adopted for extracting the wash, namely, panelling and blocking. Panelling is the most speedy and economical system, and with efficient labour very loose and drifty ground can be excavated. Strong laths, from 2 to $2\frac{1}{2}$ in., are used for backing boards, and the props are split timber, usually from $2\frac{1}{2}$ to 3 in. in diameter, and from 1 ft. 9 in. to 3 ft. 6 in. in length. In starting the strips, longer props are used than at the finish. The length of the laths used is 4 ft. 6 in. and the width of the strip inside the timber is generally 4 ft. Fig. 7 shows the face of the panelling strip, with methods of timbering. Fig. 8 shows the side view of panelling strips driven each side of the truck road. Fig. 9 shows the method of opening out loose and drifty ground. Fig. 10 shows the bearing piece hitched into the legs of the truck road set to carry the pitching-off laths.

BLOCKING.—Where the ground is too loose for panelling, or where the wash contains large boulders, or the gold values extend above 4 ft., the blocking method is adopted. The cap is usually 8 ft. in length, or the width of two sets of timber in the truck road. In opening out, if the ground is loose, a bearing piece is hitched into the legs of the truck road timber, similar to that used in opening out in panelling, or a blocking set can be fixed up in the drive and the opening-out laths pitched over it. Fig. 11 shows a side view of blocking strip with collared legs, and Fig. 12 an end view. This greatly facilitates the work of placing in position the first set inside the timber. The tops of the blocking legs are collared so that the round cap fits snugly, and, if the ground is at all heavy, a centre prop is immediately put in. The diameter of the timber used is about 6 in. and the length of the legs is arranged to suit the conditions prevailing.

As the truck roads are driven 40 ft. apart when cutting up blocking ground, each blocking strip is carried 20 ft. each side of the truck road, each strip having a width of 8 ft. The price for panelling is usually about 12s. to 14s. per fathom, the wash being delivered in the chutes above the main reef drives, and that of blocking is slightly higher. A fathom in this instance is an area of ground of 36 square feet irrespective of height. At the Prentice and

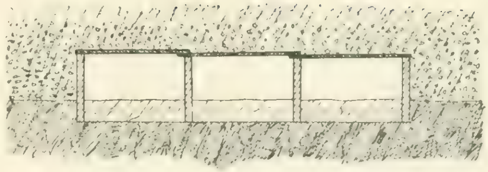


FIG. 7. FACE OF THREE PANELLING STRIP.

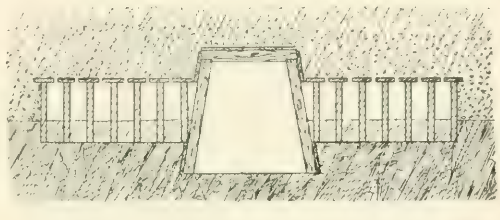


FIG. 8. SIDE VIEW OF PANELLING STRIP.

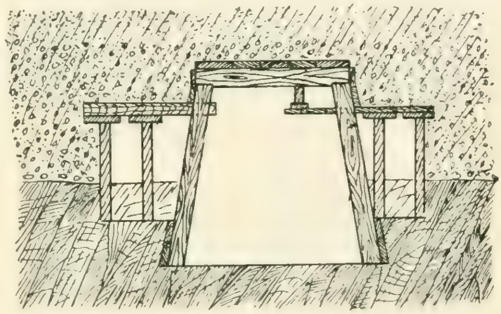


FIG. 9. OPENING-OUT PANELLING STRIP IN LOOSE GROUND.

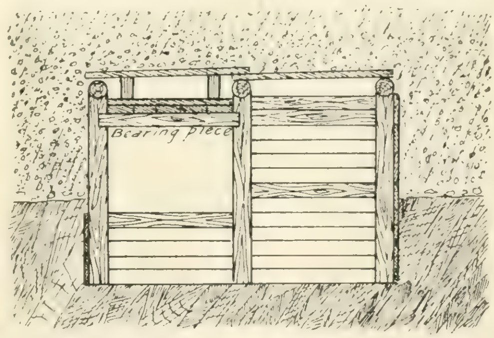


FIG. 10. END VIEW OF OPENING-OUT STRIP IN LOOSE GROUND.

Southern deep leads, at Rutherglen, from 1500 to 1700 fathoms were taken out per month, the average height of the wash excavated being 2 ft. 6 in. Therefore, as there are 1210 fathoms in an acre, the area of ground that can be excavated in a year can be estimated. This work was performed by 26 parties of men, 6 miners and 3 truckers constituting a party when panelling and blocking. The miners work singly, each working a strip on the opposite side of the truck road, and it is usually found necessary, when performing this work, to remove from 12 to 18 in. of the bedrock,

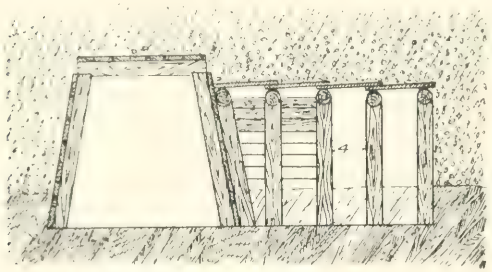


Fig. 11. Side View of Blocking Set.

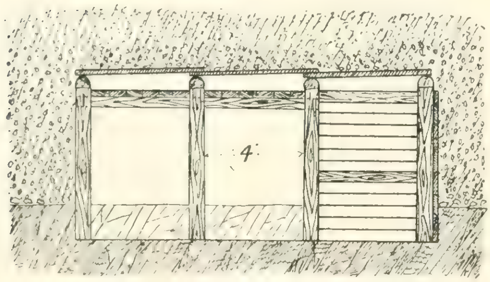


Fig. 12. End View of Blocking Set.

for where this is of an open or shattered character, the gold will be found well below the wash level.

Timber. — The mine level inside the timber is usually about 9 ft. wide by 7 ft. high. The length of the legs is usually 8 ft. 6 in. and the cap 5 ft. 6 in., with a 9 or 10 ft. spread on the bottom to allow for a double road and good water way. The grade of the road is usually about 6 in. in 100 ft. The timber used is mostly round and the main sets are generally 12 in. diameter. In rising, sawn timber is often used. Failing this, 4 to 6 in. lagging poles, framed like shaft timber take its place. The leading wash-drive timber is somewhat smaller in diameter, a 7 ft. leg and 5 ft. cap being about the usual size. In truck roading, legs are usually 5 ft. 6 in. in length and the cap from 3 to 5 ft. having a diameter of about 6 to 7 in. at the small end.

Drift Mining.—In driving through loose drifts two systems are adopted, the 'centre prop' and the 'face board' systems. The former is adopted in the Northern or Rutherglen fields and the latter in the Ballarat and the Allandale districts. The centre prop system, providing the ground is not too heavy, offers greater advantages, as lighter timber is used in the initial work and is afterwards replaced by permanent sets. (See Fig. 13 and 14). When commencing operations with this system, the

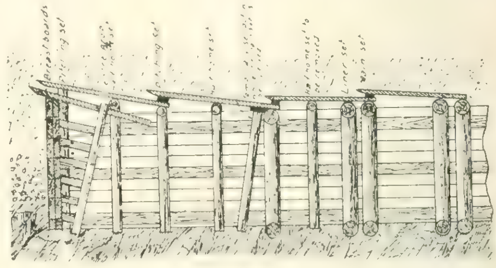


Fig. 13. Centre-Prop System.

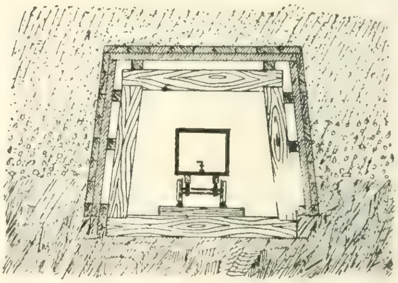


Fig. 14. Cross Section of Centre-Prop System.

laths are driven over the back of the caps for a distance of say 2 ft. They are securely tailed to prevent the points from dipping. Next the top side laths are driven the same distance as the back laths. A prop is placed standing at an angle, the top resting against the cap of the false set and the bottom securely hitched in the drive, the bottom being about 18 in. in advance of the top. A lath of sufficient length to reach half way across the face is fixed in position with one end behind the top side lath, the other end being held in position with a tom or strut driven tightly between the centre prop and the other end of the lath. Then, having driven home the other top side lath, and with a lath, one end of which is placed behind point, and of sufficient length to slightly overlap the other lath already placed in position, another strut or tom is driven between the centre prop and the outer end of this lath which will hold both laths in position tightly against the face.

Care should be taken to prevent the side laths from being pushed back. This can be done by placing distance pieces between the back end of the lath and the sets behind. This procedure continues until all the side laths have been driven home and the whole of the face boarded up. Often considerable difficulty is experienced in getting the first couple of laths in position, for it is very difficult to see, as the main cap obscures the face, and often the conditions are so bad that the laths can only be shifted about a foot at a time. When these conditions arise, and where the ground is of a very heavy nature, it is necessary to use two false sets in order to prevent the back laths from breaking.

The 'face board' system is much like the one described above, but, instead of using the centre prop, spear dogs are used to keep the centre end of the top face laths in position, one end of the spear dog being driven into the lath and the other into the cap of the main false set. (See Figs. 15, 16 and 17). The face is worked down for about 18 in. from the back laths and a main breast-board is put in. This is made of 8 by 2 in. planking and in two pieces, called the male and the female section. The male section, which reaches half way across the face, has two bolts projecting sufficiently far to receive the slot of the female section; the outer ends of both the sections are placed behind the side laths and the inner ends bolted together, forming a rigid bridge right across the face, where it is securely held without any further support.

VENTILATION. — Considerable quantities of gases exude from the drifts and washes, and various systems of ventilation have been adopted, the most general being that of forcing air from the surface by means of Root blowers down through ventilating pipes to the underground workings. These pipes range from 8 to 18 in. in diameter, and are carried through all the main levels, while smaller branch pipes conduct the air to the working faces. Suction fans have been tried but generally proved inefficient. In some of the mines, owing to the extra amount of gas in the air, the air-lock system is adopted with good results. It is well known that, when the atmospheric pressure falls below a certain point, the gases more freely exude from the wash and drifts, and, in a very short time, render work underground impossible. To overcome this, air-tight doors are built and the levels connected with the shaft or surface. A supply of air is forced down through the ventilating air pipes and delivered as above described to the working faces. When the air pressure in the working faces is raised from 1 to $1\frac{1}{2}$ lb. above the normal atmospheric pressure it forces carbonic gases back into the drifts so that work can be carried on with very little inconvenience

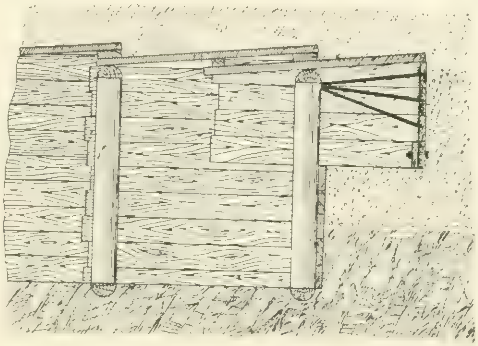


FIG. 15. SIDE VIEW OF DRIVE SHOWING FACE LATHS AND BREASTERS DRIVEN HALF HOME.

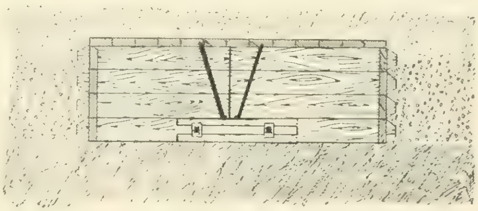


FIG. 16. FACE OF DRIVE SHOWING METHOD OF HOLDING FACE LATHS IN POSITION WITH SPEAR DOGS.

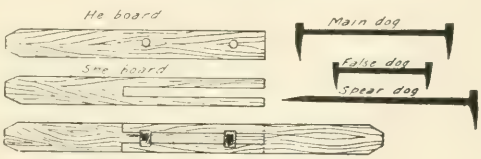


FIG. 17. DETAILS OF BOARDS AND DOGS.

to the workman. The temperature becomes slightly raised, but the candles burn brightly. Two air-tight doors are used in this method and are placed at sufficient distance apart so that, when tramming operations are in progress, one door will be opened while the other remains closed, thus keeping a constant air pressure in the workings. Root blowers are admirably suited for this work and are set to raise the air the required height so that there is no danger of over-pressure being created underground. I have often thought whether this system could not be profitably adopted in ventilating some of the shafts and works carried out by our tunnelling companies at the front.

Locks.—During the initial work of opening a mine, it is customary, in order to guard against any sudden inrush of sands or drift, to place locks or floodgates across the levels, and, if the conditions are dangerous, they are kept as close to the working face as possible. By this means any mishap or burst may be restricted and thus serious further damage to any other part of the mine prevented. To erect a lock, a hitch is cut back 1 ft. by 3 ft. wide on the top, bottom, and sides of the level. A frame set is snugly fitted against the ground and then a barricade of 10 in. square timber is placed on end, filling up the portion on each side of the tram road. Heavy half doors are hung on these timbers which, when closed, will dam-back sands and drift and allow the water to come away freely. Near the shaft a strong water-tight door is usually constructed by which the whole of the water can be dammed back from the shaft, but the locks described are only used to restrict any mishap that may occur in the working faces.

Balance Shafts.—Very often wash containing gold is found well out on the fringe or steep sides of the lead, or the lead may dip away sharply. This necessitates the driving of an intermediate level to command the ground. In some cases a rise is put up from the back of the intermediate level so that the high ground can be operated on. This rise is termed a 'jump-up' and is usually a very short one. Through it the wash is passed down to the intermediate level, and from there it is trucked to the balance shaft, where, by a simple mechanical contrivance of levers and friction brakes, the full truck is put into a cage and lowered to the main level, the weight being sufficient to hoist the truck, standing in the cage at the main level, to the intermediate level. Balance shafts are also used where the wash is of an adhesive or cementy nature, when great difficulty is experienced in getting it through the chutes.

Transport.—Tramming in deep-lead mining is a very important matter as, at times, the working faces are fully one mile away from the shaft. In such cases electric haulage or horse traction is the method adopted, but, when the wash faces are nearer the shaft, this work is generally performed by hand labour. The trucks used are slightly bell-mouthed and are sent to the surface in cages, the conditions prevailing not allowing self-dumping skips.

Values and Costs.—The value of the wash mined in deep leads varies considerably, but most of the mines require about 11 dwt. per fathom to pay expenses, and the content of the wash mined per fathom is generally from £2. 10s. to £5. The following tabulated statement of comparative costs for three months during 1908 at the Prentice & Southern Deep Leads Ltd. may be of interest:

Tonnage:	
Wash treated (fathoms)	1,641
Yield:	
Gold recovered	914 oz. 7 dwt.
Average yield per fathom	11 dwt. 3 gr.
Value gold recovered	£3,764 0s. 0d.
Working Cost per Fathom:	
Wash Extraction	£1 5s. 5d.
Wash Treatment	3s. 3d.
Pumping	7s. 7d.
Wash development	7s. 7d.
Administration and general exp's.	3s. 5d.
Total ordinary working costs	£1 8s. 8d.
Expenditure:	
Ordinary working costs	£2,359 3s. 4d.
Pumping	£624 19s. 5d.
Administration general expenses	£284 1s. 9d.
Grand total working account	£3,268 4s. 3d.
Expenditure wash development	£984 11s. 3d.
,, Reef development / ,, Rises / ,, Boring	£26 5s. 8d.
Total expenditure for month	£4,279 1s. 2d.
Water:	
Gallons of water pumped during the month	62,668,740
,, ,, ,, per day	2,021,572

The Coal Mining Organization Committee reports that the output of coal in the United Kingdom during the twelve months ended July 31 last was 254,748,000 tons, as compared with 250,368,000 tons and 281,135,000 tons during similar periods ended July 31, 1915, and July 31, 1914. The number of coal miners who joined the colours up to March 31 last was 282,200, or 25% of the average employed before the war. The replacements up to the same date were 116,900, leaving a net reduction of 165,300, or 14·8%. The question of limiting the recruiting of miners received the close attention of the Government, for it was felt that the coal output was of vital importance, not only in direct connection with war requirements, but also from the point of view of foreign trade. On June 16 it was decided to stop all recruiting, and not only so, but to arrange for all miners in the home units to return to their work. In this way, from 15,000 to 16,000 became available for the coal mines. Efforts were made to obtain additional miners by inviting men to come from British Columbia, where coal mining is depressed at present. About 170 were thus obtained, but all of them did not continue at the mines, preferring munition and other work instead.

A PROPOSED DEPARTMENT OF MINERALS AND METALS.

The following letter has been addressed to the Chairman of the Advisory Council for Scientific and Industrial Research, by the Iron and Steel Institute, the Institute of Metals, the Institution of Mining Engineers, and the Institution of Mining and Metallurgy. We refer to this matter in our editorial columns. We may suitably add here that the proposal has our entire support, and we also wish to record our gratification that the four leading societies in this country interested in mining and metallurgy have joined forces in this advocacy of the establishment of a Department of Minerals and Metals.

LONDON,
September 22, 1916.

To SIR WILLIAM S. M'CORMICK,
Chairman of the Advisory Council for Scientific and Industrial Research.

Sir,

On behalf and by authority of the Councils of the following Institutions:

THE IRON AND STEEL INSTITUTE
(Incorporated by Royal Charter as representing the Iron and Steel Industries);

THE INSTITUTE OF METALS
(Incorporated as representing the users and manufacturers of non-ferrous metals and alloys);

THE INSTITUTION OF MINING ENGINEERS
(Incorporated by Royal Charter as representing Coal and Iron Ore mining and allied industries); and

THE INSTITUTION OF MINING AND METALLURGY
(Incorporated by Royal Charter as representing the mining of minerals other than Coal and Iron Ores and the production of metals other than Iron and Steel);

We, the undersigned, have the honour to submit the following considerations and recommendations in the hope that through the intervention of the Committee of the Privy Council for Scientific and Industrial Research, measures may be taken to provide the necessary machinery for the protection and advancement of the economic welfare of the mineral and metal industries of the Empire.

The absence of effective co-ordination of the organizations of these vital industries has been demonstrated and brought into prominence by the War, in many directions. The grave results to the National interests are generally admitted.

There are highly organized Geological Surveys and Departments of Mines in nearly all foreign countries, and their influence in the development of mineral resources is a factor of the first importance. There are similar well-organized Departments in some of the British Dominions, but there is no connecting link or central 'clearing-house' in the Metropolis of the Empire to co-ordinate information on its mineral resources, to stimulate their development, and to safeguard Imperial interests.

Various Departments of the Home Government, such as the Geological Surveys and Museum of Practical Geology, the Board of Trade, the Home Office, the Imperial Institute, and, since the outbreak of the present War, the Foreign Office, the Admiralty, the War Office, and the Ministry of Munitions, have all been concerned with the collection of information bearing on the sources of supply of minerals and the production of metals. There does not appear, however, to have been any serious attempt to co-ordinate and render available even such information as has been collected by these Departments, and it is certain that there has been considerable overlapping and duplication of effort with corresponding waste and confusion.

It is, we submit, obvious that the overlapping and confusion will be seriously increased if the various Technical Committees appointed by the Advisory Council attempt to collect the information which is essential to enable the beneficent object of the Committee of the Privy Council to be attained, in its wider aspects, in regard to the mineral and metal industries.

We respectfully urge this view upon the serious attention of the Advisory Council, as already there are evidences of increasing overlapping and consequent waste of time and energy, which we believe it is one of the main purposes of the Committee of the Privy Council to eliminate as far as possible.

In the opinion of the Institutions represented by us the organization of a central Department of Minerals and Metals is imperatively necessary in the public interest, and the work of organization, which will necessarily take much time to complete, should be commenced at the earliest possible moment.

It cannot be doubted that if a properly organized and efficiently conducted Department of Minerals and Metals had been in existence, much valuable time, many lives, and vast sums of money would have been saved to the Nation in the conduct of the present War, and much of the cost and inconvenience to British Industries depending largely for their raw materials on mineral products would have been saved, with corresponding advantages to the prosecution ot the War and many industries.

A Department of Minerals and Metals should not only be in intimate relationship with the Geological Surveys and Mines Departments of the Dominions, but also with the organizations representing the different branches of the mining and metallurgical industries, whose co-operation in the work of the Department should form a vital part of its machinery.

The Geological Surveys of Great Britain and Ireland and the Museum of Practical Geology should also form an integral part of the Department.

The functions of the Department should be active and constructive. All overlapping by other Home Government departments, and also by the Institutions representing the Industries, should be absolutely prevented.

The duties of a Department of Minerals and Metals would include:

1. Arrangements for expediting the completion of Mineral Surveys of the United Kingdom and of the Crown Colonies and other British Possessions.

2. The systematic collection and co-ordination of information bearing on the occurrence, uses, and economic value of minerals and their products; special attention being devoted to securing industrial applications for newly-discovered minerals or metallurgical products and to finding mineral materials required for new metallurgical products or inventions. Some of this information should be promptly and widely disseminated in summarized form to those interested in the industries, through the medium of the existing publications of the Institutions directly concerned.

3. The investigation of all questions and problems relating to the utilization of the mineral or metallurgical resources of the Empire.

4. The co-ordination and dissemination of information on mining laws, development of mineral areas, output, processes of extraction, plant, capital employed, markets, etc.

5. A general review from time to time of the developed and undeveloped mineral resources and of the position of each mineral or metal, to ensure that the mineral wealth of the Empire is being exploited with due regard to Imperial interests.

6. Generally, to advise the Imperial Government on all questions bearing on the mining and metallurgical industries. To perform this function efficiently, it is essential that complete information should be available, and also that the industries concerned should be consulted through their respective organizations.

We feel sure that the Advisory Council will fully appreciate the urgency of the question and the necessity for prompt action, so that the process of co-ordination may be inaugurated at once.

We are, Sir,

Your obedient Servants,

WM. BEARDMORE, *President* G. C. LLOYD, *Secretary*	The Iron and Steel Institute.
GEORGE BEILBY, *President* G. SHAW SCOTT, *Secretary*	The Institute of Metals.
W. THORNEYCROFT, *President* L. T. O'SHEA, *Hon. Secretary* P. STRZELECKI, *Secretary*	The Institution of Mining Engineers.
EDGAR TAYLOR, *President* C. McDERMID, *Secretary*	The Institution of Mining and Metallurgy.

New South Wales Coal.—The amount of coal mined in New South Wales during 1915 was 9,449,008 tons, valued at £3,424,630, being a decrease of 941,614 tons and £313,131 as compared with 1914. The coal exported from the State was 4,668,394 tons valued at £2,485,448, as compared with 5,868,033 tons and £3,159,151. Of this export, 2,067,324 tons valued at £1,128,722 was shipped to overseas ports, comparing with 2,646,250 tons and £1,463,880; and 2,601,070 tons valued at £1,356,726, was shipped to Australasian ports, comparing with 3,221,783 tons and £1,695,271. The decrease was due entirely to the difficulties of shipment caused by the war. The output of coke during 1915 was 417,753 tons valued at £313,240 at the ovens, as compared with 304,800 tons and £213,068 the year before. Further large increases will be recorded in future, as the Broken Hill Proprietary's iron and steel business at Newcastle expands.

DISCUSSION

The Bawdwin Mines.

The Editor:

Sir—On page 141 of your Magazine for March 1916, in an article on the Bawdwin mines in Burma by Mr. J. D. Hoffman, I notice that credit is given to Mr. Aviet T. Sarkies as the person who was induced by a Burman to visit the Bawdwin mines in 1901. I hasten to correct this error. As a matter of fact I was the person who first visited these mines in 1900, and I knew of the enormous slags piles long before Mr. Sarkies had even heard of the mines or their whereabouts. Mr. Sarkies accompanied me in 1901 on my third visit to the mines, and I am quite sure that he will not question this statement. I claim to be the first man after the annexation of Upper Burma in 1885 who visited these mines, and brought them to the notice of the public. Mr. F. M. Kindersley, Mr. Stracey, Mr. Freymuth, Mr. Samwell, and others will confirm my claim.

It may interest you to know how I came to hear of these mines and how they were brought to the notice of the public.

I was engaged in the Imperial Service in the Public Works Department in India in 1886, and was transferred to Burma in September of the same year. Having been educated at the Civil Engineering College, Sibpur, I there obtained my first interest for mineralogy, and it became and has remained my hobby in life. During my stay from 1886 to date, I have devoted all my spare time to the investigation of the mineral wealth of Burma. On a visit to Mandalay in 1889 I met a Mr. S. G. Vertannes, who had been resident in that city since 1858, and he, knowing my love for minerals, mentioned that the Kings of Ava had received from time immemorial royalties in silver from the Bawdwin mines in the Northern Shan States. In 1889, when I was placed by the Government of Burma in charge of the construction of the Mandalay Canal Head Works, a Yunanese Chinese contractor confirmed the statement made by Mr. Vertannes, and told me of the enormous slag heaps at Bawdwin. Early in 1890 the said Yunanese Chinese contractor, on his return from Yunan, brought me a sample of the slag. Fortunately just after the receipt of this sample a large number of Palaungs from Taungpeng were met by me at the Mandalay Canal Head Works on their way to worship at the great Pagoda Payagi at Mandalay. Noticing that the Palaung women and children were decorated with silver ornaments and silver drawn threads round their waists and ankles, a thing very uncommon in Burma, I questioned them and they gave me the route to and the exact locality of Bawdwin. I immediately took leave and visited the mines in company with an old resident of Taungpeng, who took part in the last raid which the Kachins made on the Chinese at Bawdwin. On my return I visited Rangoon, and tried to influence some leading merchants there to take an interest in these mines, but as no one believed the existence of such rich deposits I was obliged to return and bring a few mule loads of the ore for their inspection and analysis. It was after my second return that I was directed to approach Sarkies Brothers, of Strand Hotel, and it was then that Mr. A. Sarkies went up with me to the mines. The subsequent history of the mines is well known and needs no amplification from me.

A. C. MARTIN.

Rangoon, August 9.

De Launay and Rand Gold.

The Editor:

Sir—Mr Draper's revival of De Launay's views, and his trenchant criticisms of some of the objections that have been raised against them, are of timely interest, if for no other reason than as an indication of the unsatisfactory state of geological research in regard to this, the world's greatest goldfield. In this respect, however, the Rand is no worse off than many other valuable and important mineralized areas that happen to be situated within British Dominions. Surely the time has come when greater efforts should be made by the State to unravel the many and perplexing geological problems that surround the occurrence of the vast mineral resources of the Empire, so that these may be exploited to the utmost economic advantage in the future.

However, I am digressing from the matter in hand, that is the consideration of De Launay's theory. One of the objections that has been raised against it is in connection with the competence of the sea to furnish the gold supply. Many estimates of the average content of gold in the seas of today have been made. Perhaps the lowest of these computations puts the average at about five milligrammes per ton and a total of 6000 million tons of gold in solution in sea water. One milligramme per ton is thus equivalent to about 1200 million tons for the total volume of solution. Many investigators put the average content at very much higher figures, thus swelling the total estimate enormously. Taking into consideration the scientific ability of the various investigators, the evidence seems to point to there being a considerably greater variation in the gold content than there is in the general alkaline salinity of ocean waters, although the latter also varies somewhat from the tropics to the poles for reasons that are well understood. There seems to be no adequate ground for concluding therefore that the low estimate given above should be considered more probable than some of the larger ones. Now the gold of the Witwatersrand System is not confined to the conglomerates, but occurs to a greater or less extent throughout the whole series of quartzites. It is worth noting in this connection that the various theories that have been promulgated from time to time to account for the gold are based principally on the study of its mode of occurrence in the conglomerates, whereas the amount of gold in these beds appears from the geological standpoint to be an almost insignificant fraction of the total amount contained in the whole series. On the basis of an average content of half a pennyweight per ton over a thickness of 3000 feet, the approximate thickness of quartzites containing the principal conglomerate beds, rather less than 5 million tons of gold would be required per thousand square miles of area, while the quantity contained in the conglomerates would be considerably less than 10% of this amount.

Allowing for the vastly greater quantities of gold occurring outside the conglomerates, and taking into consideration both the length of time required to lay down such a thickness of sediment and the large amount of changing waters likely to be involved in their deposition, the sea as a possible source of the gold does not appear to be eliminated even if it were no richer or scarcely as rich in gold as the oceans of the present day.

A noteworthy feature of many of the members of the Witwatersrand series of sediments and one which may perhaps not be entirely unconnected with contemporary solution and precipitation of gold on an extensive scale, is the presence of an abundance of iron, and this extensive deposition of highly ferruginous beds is a striking and somewhat peculiar feature of the paleozoic and older formations, not only in the Johannesburg area but over many large areas of the globe. The proximate origin of these vast accumulations of iron is for the most part practically an unsolved problem, but its presence and the manner of its occurrence are such as to suggest that it may at one time have actually been in solution in the ancient oceans, or in other words these may have contained appreciably larger quantities of iron in solution than do the oceans of today. Whatever views may be held with regard to the origin of the salts in the oceans of today, there seems no room for doubt that the salinity is a gradually increasing quantity. As river waters are in the main essentially 'carbonate' waters from which the carbonic acid radicle is eliminated after admission to the oceans, though not entirely, it is highly probable that the ratio of carbonic acid to alkaline salts was somewhat higher in the early oceans than it is in those of today, and there would thus be a greater tendency for bicarbonates to be held in solution. The high proportion of dissolved iron in some of the tropical rivers of today is also not without interest in this connection. Now ferric salts are active solvents for gold, but physico-chemical considerations strongly suggest that the elimination of iron from a mixed dilute solution would be likely to be accompanied by a partial precipitation of gold, more particularly in the later stages, if the residual iron were thrown out of solution in the form of pyrite. In a paper to the recently formed Geological Physics Society I brought forward physical and chemical evidence that indicates that the formation of pyrite from a dilute solution is probably a two-stage process, also that constitutionally pyrite appears to be of the nature of an adsorption compound of ferrous sulphide with sulphur rather than a simple three-atomed molecule. The first stage of the precipitation thus appears to be the formation of suspensoid ferrous sulphide which then slowly adsorbs a further quantity of sulphur to form pyrite or marcasite according to conditions, the sulphur not improbably being derived from dissociated hydrogen sulphide. As ferrous sulphide is an active solvent for gold, it also seems probable that the slow formation of pyrite in a solution containing dissolved gold would result in at least a fractional precipitation of the gold from such a mixed extremely dilute solution. The slow saturation of the ferrous sulphide with additional sulphur by adsorption would then be likely to cause the 'salting out' of gold dissolved by the suspensoid ferrous sulphide, so that the end products of the precipitation process would be pyrite containing mechanically entangled metallic gold. The subject is one that would be worthy of experimental investigation. If the physico-chemical theory of the process outlined above were confirmed experimentally, it would afford a pretty complete explanation of the very common association of gold with pyrite in auriferous deposits generally.

The 'life history' of these ancient formations bristles with obscure and unsolved problems, of which the origin of the gold is but one that happens to have been forced into the foreground by reason of its economic interest. The processes that have given rise to the so-called 'contorted beds,' and other ancient 'banded' formations, for instance, are wrapped in the most profound obscurity, nor has a comprehensive study of the metamorphism of the series been made. The attention of investigators appears to have been concentrated to such an extent on the more immediate aspects of the gold problem, and in endeavours to formulate theories on a minimum of observation of the sum total of geological phenomena presented by the series as a whole, that none of the gold theories seem to me to be definitely tenable, as they are not backed by sufficiently convincing and unequivocal data.

De Launay's theory is no exception in this respect, but nevertheless chemical considerations of the kind indicated above suggest that in its broadest aspect of contemporaneous deposition of gold from sea water, his theory is worthy of further critical investigation. It is important to remember in this connection that similar banket and associated auriferous quartzite deposits are by no means confined to the Witwatersrand, nor even to the African continent, for they have been reported from South America, while the association of gold in greater or less quantity with other highly ferruginous formations of early geologic time appears to be a common one.

From the point of view of the proximate origin of the gold it is thus questionable whether the Rand auriferous quartzites and conglomerates are so unique as is commonly represented, but that they may well have been impregnated with gold by processes that were operative during this period of the world's history on a greater or less scale over many large and widely separated areas of the globe.

Both the general demand for gold and the future welfare of the local industry point to the desirability of further geological work being actively undertaken on more thorough and comprehensive lines than has been the case hitherto.

This should be prosecuted by the State rather than left to the sporadic endeavours of private enterprise, which hitherto has not shown itself equal to the task of collecting and co-ordinating the data necessary for a satisfactory and convincing elucidation of this complex geological problem, despite the benefit that bids fair to accrue to the gold mining industry from its solution.

W. H. GOODCHILD.

Finsbury Pavement House,
London, E.C., September 15.

Education after the War.

The Editor:

Sir — I differ from the opinion, expressed in your editorial last month on 'Education after the War,' that the school and college holidays are too long. As far as the holidays of technical colleges are concerned, I consider that their length is a decided advantage. They are, I believe, a most valuable feature of our existing educational system, but far too little endeavour is made to use them properly. I should like to see boys encouraged to travel, and to take a direct interest in the world at large during their holidays, in order to counteract the narrowing influence that is an inevitable effect of specialized technical training. In raising the average technical strength of our industries, which is a vital necessity to the nation's future, let us not lose sight of the equal importance of maintaining the high level of self-reliance that has been the vital factor in the nation's past. The proper understanding of life is, after all, of more consequence than an expert knowledge of technology. In the further development of the best qualities of our race, I conceive our existing predilection for long school holidays to be a factor of importance. When the college course is finished, a man's chance of a long holiday is finished too. Not until he has won for himself a position of independence and comparative wealth is it, as a rule, possible for him again to take a vacation of sufficient duration to enable him to look round the world. Usually it is then too late. I wonder how many of your readers have speculated on the influence of Michael Faraday's early voyage with Humphrey Davy on his later work at the Royal Institution; it was greater, I think, than appears from a superficial reading of his life.

The subject of technical education in this country is of supreme importance, and I should like to give my views in the hope of receiving active support from your readers. My first hypothesis is that the technical education available in England is good, but that too few people take advantage of it. My second hypothesis is that more boys of the best class would enter the engineering profession if there was a recognized curriculum leading to a recognized degree or its equivalent. Thirdly, no qualification should be recognized if it fails to include, with a technical college course, several years of practical training in the workshops or other centre of paid labour engaged in the industry's support. Fourthly, systematic technical education must become a greater and more general concern of industry than hitherto has been the case in this country.

From these premises I argue that it is the firm of standing rather than the technical college that should be the alma mater of industrial youth. By this I mean that I favour the idea of firms receiving as pupils boys direct from school, and after say a couple of years in the shops sending them to technical college for a period of say three years, after which the boys would return to the firm for a final year's tuition. At present many of those who start in the works never go to a technical college, and many of those who start in the college never go through the shops. In Scotland the sandwich system of alternating college and shop training is much in vogue, but it is not, I think, a scheme that would find general favour in England.

The advantage of sending a boy straight from school into the shops outweighs in my opinion that of sending him straight to the technical college. To afford an industrial rather than an academic training is the object of this period upon which the boy now enters and it is well that he should begin at once to have a definite point of application for his thoughts. Moreover by this direct entry into a firm of standing, the boy and his parents are alike relieved of their anxiety of finding an opening for his new learning, and the secondary and public schools are themselves more directly linked up to the practical affairs of the nation in a way that cannot but be beneficial to all concerned.

As to the technical colleges, they stand to gain rather than to lose by this regime. The bulk of the tuition they afford is necessarily of the fundamental character, needed by all students alike, but in so far as they can be equipped to give special training, they all have the great advantage of teaching boys who already know that their livelihood depends on learning the subject. Under the existing method, by which the majority of the boys go first to the technical college, the students have no idea which special subjects may mean bread and butter to them, and no definite direction in which to attempt to use the fundamental teaching that all must learn alike. The consequence is that students are less well equipped for their work than they might be, and too many learn to acquire an exaggerated opinion of their own value after a college education *per se*. Unfortunately this undue self-esteem is somewhat encouraged by the educational authorities, who incline to advertise the fact that their students are sought after and can secure salaried jobs without going through the shops. The college student may be a good experimentalist because he can, at college, become experienced in laboratory work, but he is not, as a class, experienced in any industrial work, and nothing can ever be an adequate substitute for direct shop training as an apprentice among the men. In so far as any encourage their students to evade this part of their tuition, therefore, I consider the technical colleges do a great disservice. An improvement in the present position is only to be brought about by closer co-operation between the colleges and the trades, and the first move in this direction should, I think, come from the industry itself. On the other hand, it is equally essential that the colleges should work heartily in accord with any scheme of training that is ultimately determined to be the proper one for a young engineer to pursue.

A. E. BERRIMAN,
Chief Engineer.

Daimler Company, Limited,
Coventry, September 16.

[Mr. Berriman traverses our contention that the school and college holidays are too long, and he argues that they form a valuable feature of the English educational system. He admits, however, that far too little endeavour is made to use them properly. Exactly. Time not used properly is wasted, much to the disadvantage of the victim of the want of system. It is true that the holiday may be used to great benefit by travel and visits to centres of industry and learning, but such visits must be under the control of educational authorities. Mr. Berriman's remarks about opportunity for travel being absent after the conclusion of the course of study does not apply to the mining profession; most mining men get more than they want. The second part of Mr. Berriman's letter deals with the co-ordination of instruction and practical training. Though he refers more particularly to the British mechanical engineering trades, his remarks may be profitably pondered by those interested in mining and metallurgical training, for the problems are not essentially different.—EDITOR.]

SPECIAL CORRESPONDENCE

TORONTO.

PORCUPINE. — Although operations have been considerably handicapped by the scarcity of labour, production shows a steady increase as a result of extensions and additional equipment at the leading mines. The usual 4-weekly statement of the Hollinger Consolidated for the period ended August 11 shows gross profits of $220,357, from the treatment of 43,387 tons of ore, of the average value of $9·61 per ton, at a working cost of $3·78 per ton milled. The foundations for the new mill, which will have a capacity of 1600 tons per day, are about completed. The superstructure will be built during the winter, and the machinery, comprising 100 stamps and 10 tube-mills, is expected to be ready for operation next June. In order to provide greatly increased tonnage, which will then be required, development is being concentrated on the 425 ft. and upper levels. It is proposed to make the 425 ft. level the main haulage way for ore and to connect all the workings on that level with the central shaft. There are now about 1200 men employed under and above ground. The output of the Dome Mines also shows an increase, the monthly statement for August giving the production of gold as $180,000, from 40,010 tons of ore of the average value of $4·49 per ton, at an operating cost of $2·56 per ton. Exploration by diamond drilling on the Dome Extension, on which the Dome holds an option, has disclosed a number of veins, some of them of milling grade. A depth of 2000 ft. has been reached by the drills, which is the lowest ever attained in the district. The West Dome management has completed plans for a mill of about 160 tons per day capacity, the foundations of which it is proposed to lay this autumn. A new vein of high-grade ore 5 ft. in width has been found on the 300 ft. level. At the Schumacher a vein 30 in. wide giving high assays has been found on the 100 ft. level and driven on for 110 ft. A cross-cut is being run to pick it up on the 200 ft. level. The McIntyre has ordered an extensive new equipment including a 500 hp. compressor, electric hoists, and new crushing machinery. This will increase the milling capacity to 600 tons daily. Operations at the Vipond have begun to show a small profit. The production for August was slightly over $20,000, and the operating expenses $11,500. The ore is stated to show improvement at depth. The shaft of the Davidson is now down 300 ft. and cross-cutting is being started at that level. A large vein cut at 100 ft. has widened to 42 ft. on the 200 ft. level. The shaft of the Premier, now down over 100 ft., is to be sunk to the 500 ft. level. A vein recently cut on the 100 ft. level has widened to 15 ft. of $10 ore.

KIRKLAND LAKE. — Little development work is being done in this district pending the completion of the electric power transmission line from Cobalt. Actual construction work is in hand, and equipment has been delivered at various points, but though the contractors agreed to complete the line before November, it is doubtful whether they will be able to do so on account of the shortage of labour. Several companies are installing machinery and doing surface work in preparation for the coming of electric power. The Lake Shore will raise funds for the construction of a mill of 100 tons daily capacity by the sale of Treasury stock. A prospect shaft is being put down on the Costello claim in the Goodfish Lake area.

COBALT.—In order to settle difficulties which have existed for some time between the mine owners and miners, a Royal Commission was appointed last month. It was found impracticable to comply with the request of the parties and constitute a Board of Conciliation under the Industrial Disputes Act owing to lack of organization among the mining companies, which would have necessitated the appointment of a separate board for each mine. The Commission has heard evidence respecting the matters in dispute, the principal grievance of the miners being the stoppage of the bonus of 25 cents per day on account of a fall in the price of silver, the men objecting to the principle of having their pay regulated by the market for the metal. Recent reports are to the effect that the labour situation is improving and that there is no likelihood of any serious disturbance.

During August the Nipissing mined ore of an estimated value of $203,898 and shipped bullion from Nipissing and customs ore of an estimated net value of $226,341. The large flotation plant of the Buffalo, of a capacity of 600 tons daily, is now in operation treating about 100 tons per day of ore from the mine, and 500 tons of tailing from the dump, where there is an accumulation of about 300,000 tons with a silver content estimated at 1,600,000 oz. The Little Nipissing is now being operated under lease by a Detroit syndicate, and has been unwatered to the 100 ft. level where the old stopes show a quantity of low-grade ore. The Beaver is prospecting the lower contact of the diabase and Keewatin on the 1600 ft. level and has so far found two narrow veins similar in character to those on the upper levels. At the Calumet & Montana a large tonnage, of which a considerable proportion is of high grade, has been blocked out.

NICKEL REFINING IN CANADA.—After investigating a large number of possible sites the International Nickel Co. has finally decided on Port Colborne, Ontario, on the shore of Lake Erie, as the most suitable for their Canadian branch refinery and have let the contract for its construction. The plant will cover 23 acres and the estimated cost is over $3,000,000. It was at one time thought that the plant might more advantageously be located in the neighbourhood of the Sudbury mines, but representatives of the company after looking into the matter concluded that the severity of the climate so far north during the winter months was a strong objection. The British Canadian Nickel Co., which is also preparing to build a refinery, will it is understood establish it in Southern Ontario near the lake front.

CAMBORNE.

TINCROFT LIMITED.—The reduction in the capital of the Carn Brea & Tincroft company foreshadowed in my letter of last month has been effected, and the title of the company has been changed to Tincroft Limited. The nominal capital is now £37,500 as compared with £150,000 previously, so that a really substantial sum has been written off. However, seeing that the Carn Brea sett has long been abandoned, and that approximately only one fourth of the capital was represented by tangible assets, it was clearly the right action to take. The mine in the bottom is responding well to development, and if the prices of tin and wolfram are maintained, there would appear to be fair chances of the priority shareholders in the near future receiving on their money some interest in the shape of dividends. Captain W. Thomas, at the meeting, introduced a new term in mining nomenclature by referring to a large 'sensible' lode. Such a description used in this connection is too absurd to expect its general adoption, but one cannot help wondering what a 'foolish' lode would represent!

SUBSTITUTION IN THE MINES. — For months past it has been suggested in many quarters that the mines were acting as a sort of refuge for men of military age who desired to escape service, particularly those mines producing wolfram, where all employees are badged. Partly to meet such complaints, but mainly to meet the need of the army authorities, a substitution scheme has been introduced whereby the younger men are to be replaced by others above military age or by men ineligible for the Army through some cause which does not prevent them working efficiently. The military authorities in effect undertake to find another man capable of doing the work of the employee claimed by them. The mine managers have promised their co-operation, but it is doubtful in my opinion whether much can be done in this direction in connection with the mines, although such a plan might serve in other businesses. The absurd part of the whole affair, however, is that one government department instructs you to hold on firmly to all effective workmen because your products are urgently needed, while another department issues instructions which, if adopted, would result in closing down the mine.

SUGGESTED DEPARTMENT OF MINERALS AND METALS. — The Advisory Council for Scientific and Industrial Research has recently submitted to the Government a suggestion that a department of Minerals and Metals should be set up for the purpose of taking measures to provide the necessary machinery for the protection and advancement of the economic welfare of the mineral and metal industries of the Empire. This is a matter in which Cornwall and Devon are vitally interested, and the adoption of such a proposal might probably result in much more attention being paid to their mineral resources if only the Cornwall Chamber of Mines, or should that organization not shortly materialize, then some other body representative of the mining industry, will see that the possibilities of the West of England as a mining field are prominently brought before those authorities concerned. Lack of co-operation, and an unwillingness to join in any movement for the good of the industry as a whole, unless some immediate and direct tangible benefit was forthcoming, have been responsible for much of the past neglect of mining in the West of England. Cornishmen and others interested must be up and doing in these times.

PERSONAL

Readers of the Magazine are invited to announce their movements and appointments in this column.

A. H. ACKERMANN has left for South Africa.

A. F. S. ANDERSON has left the staff of the Eastern Smelting Co. at Penang, and has returned to Australia.

PERCY E. BARBOUR, managing editor of the *Engineering and Mining Journal*, has received a commission as lieutenant in the 22nd New York Engineers, and is now on the Mexican border.

JOHN BALLOT is leaving London for the United States in connection with the forthcoming hearing of the Minerals Separation versus Hyde case in the Supreme Court at Washington.

H. B. BATEMAN is here on leave from West Africa.

Sir GEORGE T. BEILBY has been re-elected president of the Institute of Metals.

EDWIN S. BERRY, who has joined Pope Yeatman as a partner, sailed for Peru on September 16 to undertake mine examination in that country.

J. M. CALDERWOOD is here from Johannesburg.

A. R. CANNING, manager for the Northern Nigeria Bauchi company, is in London.

A. P. COLEMAN, of the University of Toronto, is making investigations on the Labrador coast.

G. H. CUNNINGHAM, lately with the Anaconda company, has been appointed chief engineer for the Electrolytic Zinc company of Australia.

W. R. DEGENHART has left for San Francisco.

JAMES ELCE has gone to Ekatrinoslav, South Russia, to join the staff of the New Russia company.

N. H. EMMONS, jr., has been appointed manager for the Tennessee Copper company.

B. DU FAUR, formerly of Mount Morgan, is now at the Burra copper mine, Kooringa, South Australia.

W. R. FELDTMANN left on September 19 for West Africa on a periodical visit to the mines of the Ashanti Goldfields Corporation.

JOHN W. FINCH has gone to China for a New York syndicate.

MYRON A. FOLSOM, legal adviser to the Bunker Hill and Sullivan Co., will undertake the commercial work of marketing the company's smelter products, and will have his office at San Francisco.

S. E. FRASER, formerly with the Waihi company, has been appointed engineer for the Broken Hill Associated Smelters, Port Pirie.

FRASER & CHALMERS Ltd. are moving their offices from 3 London Wall Buildings to Moorgate Hall, London, E.C., on November 1.

LIEUTENANT G. A. GARLAND, a younger member of the family so long connected with John Taylor & Sons, was killed at the front on September 16, three days after his arrival in France.

JAMES GEORGE has taken charge of the dredging operations of the Rimu Options, Limited, at Hokitika, New Zealand.

H. W. GEPP, manager for the Amalgamated Zinc (De Bavay) company, is at Winthrop, California, experimenting with the Bully Hill electrolytic zinc plant.

A. F. GERNET, director, and S. J. WEIS, dredging engineer, for the Lenskoi, have returned from Bodaibo to Petrograd with recommendations for the proposed dredging installation.

N. E. GIBLIN, formerly manager of the Golden Ridge mine at Kalgoorlie, has been appointed manager of the Edna May Central mine at Westonia.

J. L. GLASSON, of the University of Tasmania, has been appointed a member of the Australian Advisory Council in Scientific Research.

FRED HELLMANN succeeds POPE YEATMAN as consulting engineer for the firm of Guggenheim Brothers.

A. W. HOOKE, manager for the Forum River company, is expecting to return to Nigeria next month.

JOHN M. ILES, manager for the Rayfield company, arrived in London from Nigeria on September 20.

M. H. KURYLA is superintending the erection of an electrolytic zinc plant for the Judge Mining and Smelting Co., at Park City, Utah.

JOHN LANGDON, the manager of the Lansell's South Red White & Blue mine at Bendigo, died on August 9. He was a native of Cornwall, and had been at Bendigo since 1873.

JOHN MACFARLANE is here from West Africa.

E. T. MCCARTHY has been elected president of the Royal School of Mines (Old Students) Association, with ERNEST R. WOAKES and S. J. TRUSCOTT as vice-presidents.

A. G. M. MICHELL is visiting Bendigo to advise on the drainage of the Sheephead and Garden Gully lodes.

P. B. MCDONALD has left the editorial staff of the *Mining and Scientific Press*.

WILLET G. MILLER and T. F. SUTHERLAND have concluded their visit to the nickel mines of New Caledonia, and have returned to Canada.

DEANE P. MITCHELL sailed for New York on September 21.

A. LEGGET NEALE has been elected president of the Pilgrims Rest Mines & Claimholders Association.

Captain B. H. NICOLSON has been at home on short leave.

C. H. OLIVER has left Tarkwa for England.

G LLOYD OWEN has been appointed manager for the Adelong Creek Dredging Co., New South Wales.

H. C. PARMELEE, western editor of *Metallurgical and Chemical Engineering*, has been appointed president of the Colorado School of Mines, succeeding W. B. PHILLIPS, resigned.

W. PELLEW-HARVEY is at Great Cobar, New South Wales, having travelled thither from London by the Canadian route.

H. N. SHERMAN, of the Tata Iron and Steel Co., is here from India.

WARWICK SMITH has left Australia for India.

J. ERNEST SNELUS is expected home in November from Naraguta.

H. G. THIELE has joined the editorial staff of the *Mining and Scientific Press*.

MICHAEL THUNDER has met his death at the front. He was for some time manager of the Tekka tin mine in Perak, and more recently was in charge at Gopeng.

A. F. TONNIES is with the Bentong Tin Co., Pahang, Federated Malay States.

F. W. TRAPHAGEN has resigned as professor of metallurgy in the Colorado School of Mines.

WILLIAM TRURAN has returned to Georgetown, California.

J. B. TYRRELL has returned to Toronto from British Columbia.

J. A. WILKINSON has been elected president of the Chemical, Metallurgical, and Mining Society of South Africa.

ERNEST WILLIAMS has returned from Chile.

WILKENS & DEVEREUX have moved their London office from 62 London Wall to 7 Victoria Avenue, Bishopsgate. W. F. A. THOMAE will continue to act as their London representative in the absence of GORDON S. DUNCAN on war service.

O. H. WOODWARD, recently awarded the Military Cross, is a graduate of the Charters Towers School of Mines, and before the war was on the staff of the Mount Morgan company.

METAL MARKETS

COPPER, TIN, LEAD, AND SPELTER DURING SEPTEMBER.

COPPER.—Prices have been firm and have steadily risen from £110 cash and £107 three months to £118. 10s. cash and £115 three months for standard. Refined has fully responded, quotations showing a rise in the same period of no less than £10 per ton. In New York the quotation has risen from 27¼ to 28c. Great activity prevails in the consuming industries and there is evidence that, owing to scarcity of labour and plant, the refinery output is barely able to cope with the demand or to put through the available supply of rough material. The margin of £20 between standard and electrolytic sufficiently proves the latter. Good class furnace material is, however, not plentiful, Chile brands being sent mostly to America, while other makes are going direct to the refineries. In addition to large purchases for Vladivostok made in Japan, the Allied Governments have bought 200,000 tons of electrolytic in America, for delivery over the first half of next year. This is giving buyers confidence in purchasing ahead. Hitherto transactions beyond 1916 have been avoided. The Allies appear to be still buyers for this year's shipment. There is a growing demand for best selected in this country, as for many purposes this can take the place of electrolytic. In consequence the margin between the prices of the two qualities is narrowing.

Average prices of cash standard copper: September 1916, £114. 1s. 5d.; August 1916, £110. 8s. 3d.; September 1915, £69. 1s. 2d.

TIN.—Tin has been dull until quite the end of the month when it became firm, and indications point to the control having got into strong hands. £170 was touched at one time, but this price has often been in late years the point of recovery on a declining market. The month closed at £175. 10s., and a further advance appears imminent. In this country consumption is poor, and is likely to remain so with the present scarcity of labour. For August only 65% of the tinplate mills of South Wales were in operation. America, however, is very active, and has bought considerable quantities both in London and the Straits. Java has shown great reserve, and little has come on the market lately. The Straits, too, after considerable activity, is holding for prices well above the home market. Export licenses both from the Straits and from this country are given with great caution.

Average prices of cash standard tin: September 1916, £171. 8s. 4d.; August 1916, £169. 19s. 9d.; September 1915, £152. 18s. 4d.

LEAD.—There is a marked scarcity of this metal. While the nominal market appears steady there is an underlying strength, which fails to manifest itself only because supplies are so scarce that raising the price fails to bring out more metal. The American quotation has risen to 7c., but this is far above the London parity, and no relief is to be looked for from there. Supplies from Spain reaching here are small apart from government imports, and even these latter are insufficient. An active market would undoubtedly develop if material were available.

Average prices of soft foreign lead: September 1916, £29. 17s. 5d.; August 1916, £29. 2s. 7d.; September 1915, £23. 3s. 0d.

SPELTER.—This market has become more active. Prices were officially raised to £54–£47, but toward the close of the month, they fell back a little to £52–£46. The early estimates of the increase of American production have not been reached, and there is much talk of spelter below 8c. being unproductive. Remembering prices of pre-war days, and the low prices of ores, it is hard to understand how the present level does not leave producers a handsome profit. Meanwhile, the market looks like improving considerably, American producers holding for stiff advances. Demand keeps good, especially for higher grades, which like copper can be taken in unlimited quantities.

Average prices of good ordinary brands; September 1916, £48. 15s. 9d.; August 1916, £47. 19s. 7d.; September 1915, £67. 17s. 9d.

The daily prices of copper, tin, lead, and zinc on the London Metal Exchange are given in our pages of statistics. The following are the quotations for various brands and products of copper on October 5: Standard £119–£120 per ton cash, £116–£117 three months; electrolytic £142 cash, £139 three months; tough £135; best selected £136; India sheets £164; American wire bars £143; solid drawn tubes 19½d. per lb.; brazed tubes 19¼d.; wire 18½d.; yellow metal 16d. Brass, solid drawn tubes, 16¼d. per lb.; brazed tubes 18¼d.; rods 15¾d.; sheets 15¾d.; wire 15⅝d. The prices of tubes and wire are subject to 2½% discount. Sulphate of copper £52 per ton.

The following are the quotations of various brands of tin on October 5: Standard cash £177. 10s. 0d., three months £178; English ingots £178. 10s.; Straits £177. 12s. 6d.; Australian £177. 12s. 6d.; Eastern £179.

On October 5 soft foreign lead was quoted at £30 10s. 0d. cash and £29 10s. three months, English lead £32 5s. cash. Spelter, ordinary brands, £54 cash, £49 three months; English £62.

ANTIMONY.—There is no new business to report and the quotations are nominal. The Government price is £95 per ton. In America the market has become dull once more, the boom reported last month having been brief. The price there varies considerably, but from 11 to 12 cents per lb. may be given as the average at present.

QUICKSILVER.—The quotation for Spanish quicksilver has remained steady at £17. 15s. per flask of 75 lb. In America the market has been quiet and prices remain around $75 per flask.

BISMUTH.—This metal continues under Government control, being required in the manufacture of fusible metals and also of drugs; 11s. per lb. is mentioned as a price, but outsiders would have to pay more. In America the quotation is $3·25 per lb.

CADMIUM.—The export of this metal to neutral countries is now prohibited. The price is very firm at 7s. 9d. per lb.

PLATINUM.—The Government buying price has been raised from 190s. to 200s. per ounce. Any not required by the Government is sold at 220s. per ounce. In America the price has advanced again, and stands at $85 per ounce as compared with $65 a month ago.

NICKEL.—The quotation for nickel in this country remains at £225 per ton. In the United States the price is unchanged at 45 to 50 cents per lb., and 5 cents higher for electrolytically refined metal.

ALUMINIUM.—The Government still controls the market with the price at about £150 per ton. In the United States the demand is strong and the price is quoted at 60 to 62 cents per lb.

IRON AND STEEL.—The iron trade comes more and more under the control of the Government. The latest restriction is in connection with structural steel, none of this being allowed for use in the construction of buildings except under special permit. The demand for pig iron is as strong as ever, and the requirements of France are pressing. The control price of No. 3

Cleveland pig iron is 87s. 6d. per ton ; 97s. 6d. is being paid for odd lots ; the stocks at Middlesbrough continue to decrease. East Coast hematite pig is 122s. 6d. and West Coast hematite pig 127s. 6d. ; under 0·02% phosphorus and sulphur 140s. South Staffordshire cold blast pig is 182s. 6d. The control price of steel angles is £11. 2s. 6d., boiler plates £12. 10s., steel rails £10. 17s. 6d. Galvanized sheets are quoted at £28. 15s. Public quotations for iron ore are withdrawn by order of the Government.

COAL AND COKE.—Best South Wales steam coal is not quoted ; small steam coal of best quality is priced at 29s. to 30s. at Cardiff. Best Newcastle steam coal is 42s. 6d. Anthracite at Swansea is 32s. Furnace coke at Middlesbrough is 28s. ; best furnace coke at South Wales 50s. to 55s.

MANGANESE.—There are no current quotations for manganese ores. Until recently, Indian ores for next year's delivery were quoted at 2s. 6d, per unit delivered, and Brazilian at 4s. per unit, both on a 50% basis. Ferro-manganese 80% is quoted at £25 per ton for home delivery and £30 to £40 for export. More is now being produced in the United States, and the American market for English ferro-manganese is not quite so stringent. Metallic manganese 90 to 95% carbonless is quoted in Sheffield at 4s. per pound.

TUNGSTEN.—For some time the Government price of wolfram and scheelite ores was 55s. per unit on the basis of 70% WO_3. These prices are now withdrawn and public quotations are prohibited. In the United States, tungsten ore is quoted at $16·50 to $17 per unit. The official price of high-speed tool steel is 2s. 10d. per lb. for 14% tungsten content, and 3s. 10s. for 18% tungsten content. The prices for returned scrap are 5d. per lb. for millings and turnings and 6d. per lb. for bar-ends. Ferro-tungsten 80 to 90% low carbon is quoted at 5s. 6d. per lb. of tungsten content ; tungsten metal powder 96 to 98% 6s. 3d. per lb., based on ore at 60s. per unit, with a scale of 1d. per lb. with each variation of 1s. per unit for the ore.

MOLYBDENUM.—The Government has withdrawn the official price of molybdenite of 105s. per unit basis 90% MoS_2, and no quotation is now available.

TITANIUM.—The Sheffield quotations for ferro-titanium are : 15 to 18% Ti, 5 to 8% carbon, 6½d. per lb. ; 23 to 25% Ti, carbonless, 1s. 5d. per lb.

FERRO-SILICON.—The Sheffield quotations are : 45 to 50%, basis 45% Si, £28. 10s. per ton, scale 7s. 6d, per unit ; basis 75% Si, £48 per ton, scale 8s. per unit.

COBALT.—96 to 98%, 7s. 6d. per lb.

VANADIUM.—Ferro-vanadium is quoted at 15s. per lb. of vanadium contained.

CHROMIUM.—Chalas & Sons quote chrome ores as follows : New Caledonia ore 53 to 55%, basis price for 50% Cr_2O_3, 37s. 6d. f.o.b., scale 2s. 6d. per unit. Baluchistan ore 53 to 55% Cr_2O_3, last sale 60s. per ton f.o.b., scale 2s. 6d. per unit. No quotation for Rhodesia chrome ore.

SILVER.—The silver market continues to be firm and little variation has taken place in the price. The quotation has kept within the limits of 32¾d. and 33d. per standard ounce. There is no reason to expect any great fall in price at present, as the requirements for coinage are still considerable.

Many of the rarer metals are never publicly quoted in London and seldom in New York. Thus it is difficult to tell the values of metals of the platinum group. Magnesium is only produced in England for the Government, it having been imported previously from Germany of recent years. The quotation in America is $3·75 to $4 per lb. Selenium, used nowadays by electricians, is quoted in America at from $3 to $5 per lb.

PRICES OF CHEMICALS. October 9.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	2	0
,, 60%	,,	3	0	0
,, Glacial	,,	6	0	0
Alum	per ton	14	0	0
Alumina, Sulphate of	,,	18	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	30	0	0
,, Chloride of, grey	per cwt.	1	14	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	36	0	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bleaching Powder, 35% Cl.	,,	19	0	0
Borax	,,	33	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	53	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	5	0
Lead, Acetate of, white	,,	90	0	0
,, Nitrate of	,,	68	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	7
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	4
,, Carbonate	per ton	95	0	0
,, Chlorate	per lb.		2	7
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb.		7	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	0
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb.		1	3
,, Acetate	per ton	80	0	0
,, Bicarbonate	,,	6	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	18	0	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 95%	,,	18	0	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	15	0
,, Sulphide	,,	22	0	0
Sulphur, Roll	,,	16	0	0
,, Flowers	,,	17	0	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tin Crystals	per lb.		1	4
Zinc Chloride, solution 100°T.	per ton	31	0	0
Zinc Sulphate	,,	27	0	0

STATISTICS.

PRODUCTION OF GOLD IN THE TRANSVAAL.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	[illegible]	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767
July	733,485	27,602	761,487	3,232 891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408

NATIVES EMPLOYED IN THE TRANSVAAL MINES.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1915	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500

COST AND PROFIT ON THE RAND.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247
May	2,382,298	26 7	18 2	8 2	977,263
June	2,296,520	27 0	18 3	8 6	977,681
July	2,370,244	26 1	17 10	8 0	949,606

PRODUCTION OF GOLD IN RHODESIA AND WEST AFRICA.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	333,070	135,289	127,107
July	336,565	322,365	140,290	128,574
August	344,493	338,001	139,364	125,143
September	321,085	—	135,744	—
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	2,624,328	1,706,473	1,079,081

PRODUCTION OF GOLD IN WESTERN AUSTRALIA.

	Export oz.	Mint oz.	Total oz.	Total value £
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181
July	555	98,859	99,414	422,271
August	*	89,522	*	*
September	*	85,978	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

AUSTRALIAN GOLD PRODUCTION.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	72,200	18,000
July	154,800	100,600	88,830	85,400	23,000
August	80,300	66,800	93,050	86,000	24,000
September	138,900	—	79,470	—	—
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	702,900	1,078,560	666,400	253,000

PRODUCTION OF GOLD IN INDIA.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	191,404
August	193,998	196,560	197,984	192,784
September	191,642	195,843	195,952	192,330
October	194,314	198,191	195,531	—
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	1,716,688

DAILY LONDON METAL PRICES

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard	Silver
Sept.	£ s. d.	£	£ s. d	£	£ s. d	d.
1	110 5 0	131	31 0 0	49	170 5 0	$32\frac{7}{16}$
4	110 5 0	131	30 15 0	49	170 5 0	$32\frac{1}{8}$
5	109 10 0	131	30 10 0	49	170 15 0	$32\frac{3}{8}$
6	109 0 0	131	30 5 0	$48\frac{1}{2}$	171 0 0	$32\frac{1}{2}$
7	109 15 0	132	30 5 0	$48\frac{1}{2}$	170 15 0	$32\frac{5}{16}$
8	110 5 0	132	30 5 0	50	169 15 0	$32\frac{1}{2}$
11	111 5 0	132	30 0 0	50	169 10 0	$32\frac{3}{8}$
12	111 10 0	133	30 0 0	52	169 10 0	$32\frac{5}{16}$
13	115 0 0	133	30 0 0	54	169 15 0	$32\frac{3}{8}$
14	117 0 0	134	30 0 0	54	170 10 0	$32\frac{1}{2}$
15	116 0 0	136	30 5 0	54	170 5 0	$32\frac{3}{8}$
18	116 0 0	137	30 5 0	55	170 15 0	$32\frac{11}{16}$
19	116 0 0	137	30 10 0	56	171 10 0	$32\frac{5}{8}$
20	116 10 0	137	30 10 0	56	172 5 0	$32\frac{5}{8}$
21	116 10 0	138	30 10 0	55	172 17 6	$32\frac{3}{4}$
22	115 10 0	138	30 10 0	54	171 5 0	$32\frac{3}{4}$
25	115 10 0	138	30 10 0	52	172 0 0	$32\frac{15}{16}$
26	115 10 0	139	30 10 0	52	171 17 6	$32\frac{15}{16}$
27	117 0 0	140	30 10 0	52	173 0 0	$32\frac{15}{16}$
28	117 10 0	140	30 10 0	52	174 5 0	$32\frac{7}{8}$
29	118 10 0	141	30 10 0	52	175 10 0	$32\frac{15}{16}$
Oct.						
2	118 10 0	141	30 10 0	52	175 5 0	$32\frac{7}{8}$
3	119 10 0	141	30 10 0	52	175 10 0	$32\frac{3}{4}$
4	119 10 0	142	30 10 0	54	176 15 0	$32\frac{9}{16}$
5	119 10 0	142	30 10 0	54	177 10 0	$32\frac{1}{2}$
6	120 10 0	143	30 10 0	57	178 0 0	$32\frac{1}{2}$
9	120 10 0	143	30 10 0	57	178 0 0	$32\frac{1}{2}$
10	122 10 0	143	30 10 0	56	181 5 0	$32\frac{5}{16}$

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	Aug. 1916	Sept. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	2,285	3,611	26,244
,, Matte and Precipitate	38,372	4,922	2,110	31,754
,, Metal (unwrought and part wrought)	180,368	10,492	7,118	86,663
Copper and Iron Pyrite	903,401	98,775	56,008	764,210
Tin Concentrate	44,748	5,182	2,724	26,087
,, Metal	38,896	2,895	2,633	26,596
Manganese Ore	377,324	46,696	42,389	348,394
Lead, Pig and Sheet	256,476	14,960	10,171	118,975
Zinc (spelter)	74,520	6,060	5,775	36,516
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	17,400	40,740	2,437,679

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons.

	July 31, 1916	Aug. 31, 1916	Sept. 30, 1916
	Tons	Tons	Tons
Standard Copper in England	1,382	1,870	1,379
Fine Copper in England	2,058	2,969	1,783
,, ,, Havre	2,525	2,675	2,634
,, ,, Afloat from Chile	2,175	850	1,575
,, ,, ,, from Australia	3,500	3,150	3,000
Total Visible Supply	11,640	11,514	10,371
Fine Copper in Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1916	Long tons	1916	Long tons
July	16,812	January	21,863	July	35,048
August	16,289	February	20,548	August	34,700
September	14,327	March	24,006	September	28,572
October	26,153	April	19,980	October	—
November	19,396	May	14,700	November	—
December	32,936	June	38,277	December	—
Total 1915	257,915			Total 1916	237,694

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	July 31, 1916	Aug. 31, 1916	Sept. 30, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,074	1,701	1,652
Ditto, Landing and in Transit	1,190	1,175	1,360
Other Standard, Spot and Landing	1,595	1,260	1,018
Straits, Afloat	3,640	3,145	3,028
Australian, Afloat	500	385	265
Banca, on Warrants	—	—	—
Ditto, Afloat	1,067	753	840
Billiton, Spot	—	—	—
Ditto, Afloat	393	477	423
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,825*	1,291*	1,581*
Afloat for United States	4,667	4,705	3,000
Stock in America	5,028	4,758	4,769
Total Stock	20,979	19,648	17,933

* Including 605 tons on board enemy's ships either captured or lying in neutral ports.

Shipments and Imports of Tin
Reported by A. Strauss & Co. Long tons.

	Year 1915	Aug. 1916	Sept. 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	2,370	1,910	20,425
Straits to America	31,565	1,490	600	18,520
Straits to Continent	11,024	666	760	6,636
Australia to U.K.	2,481	63	90	1,932
U.K., Holland, and Continent to America	14,967	1,550	1,110	11,468
Imports of China Tin into U.K. and America	3,012	—	100	1,290
Imports of Bolivian Tin into Europe	22,591	2,822	1,093	11,192

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	510
July	140	357	432	455	506
August	201	406	228	438	498
September	196	422	289	442	—
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	4,142

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.

Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	3,517
August	4,454	4,620	3,591	4,046	3,732
September	4,115	4,379	3,623	3,932	3,636
October	3,905	4,409	3,908	3,797	—
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	32,610

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
Year 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179½	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10
July 17	186½	£17,114	£91 15 4
July 31	172¼	£16,172	£93 17 8
August 14	166	£15,955	£96 2 4
August 28	180¼	£17,345	£96 4 8
September 11	184	£17,113	£93 0 2
September 25	166½	£15,980	£95 19 7

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.
Quotations are given in shillings.

GOLD, SILVER, DIAMONDS:	Oct. 1 1915	Sept. 5 1916	Oct. 5 1916
RAND			
Bantjes	5	16	15
Brakpan	62	89	90
Central Mining (£12)	125	127	140
Cinderella	4	6	6
City & Suburban (£4)	41	36	40
City Deep	64	85	90
Consolidated Gold Fields	26	34	32
Consolidated Langlaagte	37	29	27
Consolidated Main Reef	20	17	19
Consolidated Mines Selection (10s).	9	20	23
Crown Mines (10s.)	77	51	60
Daggafontein	8	16	16
D. Roodepoort Deep	14	14	12
East Rand Proprietary	22	15	17
Ferreira Deep	42	27	27
Geduld	33	43	48
Geldenhuis Deep	20	23	23
Gov't Gold Mining Areas	26	47	52
Heriot	57	47	49
Jupiter	6	8	8
Kleinfontein	23	32	30
Knight Central	12	13	12
Knight's Deep	25	29	29
Langlaagte Estate	18	17	17
Luipaard's Vlei	7	8	8
Main Reef West	7	8	6
Meyer & Charlton	106	104	102
Modderfontein (£4)	307	377	377
Modderfontein B	110	136	137
Modder Deep	100	150	147
Nourse	21	17	23
Rand Mines (5s.)	83	69	75
Rand Selection Corporation	39	71	75
Randfontein Central	12	11	12
Robinson (£5)	28	16	16
Robinson Deep	21	35	34
Rose Deep	34	22	22
Simmer & Jack	8	6	6
Simmer Deep	2	2	4
Springs	25	57	66
Van Ryn	54	39	40
Van Ryn Deep	51	69	68
Village Deep	36	32	33
Village Main Reef	22	13	16
Witwatersrand (Knight's)	57	55	53
Witwatersrand Deep	34	22	25
Wolhuter	11	11	11
OTHER TRANSVAAL GOLD MINES:			
Glynn's Lydenburg	10	15	14
Sheba (5s.)	3	2	2
Transvaal Gold Mining Estates	32	24	22
DIAMONDS IN SOUTH AFRICA:			
De Beers Deferred (£2 10s.)	200	254	240
Jagersfontein	56	79	77
Premier Diamond Defer'd (2s. 6d.)	80	110	107
RHODESIA:			
Cam & Motor	14	11	11
Chartered	10	13	11
Eldorado	9	9	9
Enterprise	5	5	6
Falcon	8	14	14
Giant	5	7	8
Globe & Phœnix (5s.)	27	28	30
Lonely Reef	20	21	20
Shamva	37	32	29
Wanderer (5s.)	1	1	1
Willoughby's (10s.)	4	5	5
WEST AFRICA:			
Abbontiakoon (10s.)	8	6	6
Abosso	8	9	9
Ashanti (4s.)	17	18	18
Prestea Block A	8	8	8
Taquah	14	20	20
WEST AUSTRALIA:			
Associated Gold Mines	4	3	4
Associated Northern Blocks	4	3	3
Bullfinch	6	4	4
Golden Horse-Shoe (£5)	39	36	36
Great Boulder Proprietary (2s.)	15	13	12
Great Boulder Perseverance	1	1	1
Great Fingall (10s).	2	1	1
Ivanhoe (£5)	44	42	42
Kalgurli	19	12	9
Sons of Gwalia	16	15	14

GOLD, SILVER, *cont.*	Oct. 1 1915	Sept. 5 1916	Oct. 5 1916
OTHERS IN AUSTRALASIA:			
Blackwater, New Zealand	15	13	13
Consolidated Gold Fields of N.Z.	11	6	6
Mount Boppy, New South Wales	7	10	10
Progress, New Zealand	5	3	2
Talisman, New Zealand	21	11	11
Waihi, New Zealand	36	42	36
Waihi Grand Junction, New Z'lnd	21	19	17
AMERICA:			
Alaska Treadwell (£5), Alaska	130	107	80
Buena Tierra, Mexico	10	13	13
Camp Bird, Colorado	4	8	7
Canadian Mining, Ontario	8	10	12
Casey Cobalt, Ontario	5	5	6
El Oro, Mexico	7	9	9
Esperanza, Mexico	7	12	11
Frontino & Bolivia, Colombia	9	11	12
Le Roi No. 2 (£5), British Columbia	10	10	10
Mexico Mines of El Oro, Mexico	64	72	77
Oroville Dredging, California	14	17	17
Plymouth Consolidated, California	15	23	21
St. John del Rey, Brazil	18	15	17
Santa Gertrudis, Mexico	7	12	11
Tomboy, Colorado	20	22	21
RUSSIA:			
Lena Goldfields	30	39	35
Orsk Priority	9	26	25
INDIA:			
Champion Reef (2s. 6d.)	11	6	7
Mysore (10s.)	80	75	75
Nundydroog (10s.)	25	27	27
Ooregum (10s.)	23	21	21

COPPER:

Anaconda (£10), Montana	314	357	405
Arizona Copper (5s.), Arizona	35	41	47
Cape Copper (£2), Cape Province	50	80	80
Chillagoe (10s.), Queensland	½	¼	¼
Cordoba (5s.), Spain	2	3	4
Great Cobar (£5), N.S.W.	2	3	3
Hampden Cloncurry, Queensland	28	36	35
Kyshtim, Russia	37	55	53
Messina (5s.), Transvaal	14	11	11
Mount Elliott (£5), Queensland	55	79	81
Mount Lyell, Tasmania	22	26	28
Mount Morgan, Queensland	40	37	36
Rio Tinto (£5), Spain	1080	1235	1265
Sissert, Russia	21	22	21
Spassky, Russia	40	42	41
Tanalyk, Russia	36	55	55
Tanganyika, Congo and Rhodesia	23	50	54

LEAD-ZINC:

BROKEN HILL:			
Amalgamated Zinc	25	31	32
British Broken Hill	19	26	25
Broken Hill Proprietary (8s.)	44	60	54
Broken Hill Block 10 (£10)	16	24	24
Broken Hill North	39	47	45
Broken Hill South	125	166	160
Sulphide Corporation (15s.)	17	26	26
Zinc Corporation (10s.)	12	16	15
ASIA:			
Burma Corporation	31	75	86
Irtysh Corporation	32	50	47
Russian Mining	15	21	20
Russo-Asiatic	81	125	121

TIN:

Aramayo Francke, Bolivia	27	27	26
Bisichi, Nigeria	5	8	10
Briseis, Tasmania	4	4	5
Cornwall Tailings, Cornwall	12	3	—
Dolcoath, Cornwall	5	10	10
East Pool, Cornwall	9	35	36
Ex-Lands Nigeria (2s.), Nigeria	1	1	1½
Gopeng, Malay	27	30	29
Mongu (10s.), Nigeria	9	8	9
Naraguta, Nigeria	11	14	15
N. Nigeria Bauchi (10s.), Nigeria	2	2	2
Pahang Consolidated (5s.), Malay	6	12	11
Rayfield, Nigeria	2	6	7
Renong Dredging, Siam	20	30	39
Ropp (4s.), Nigeria	13	16	17
Siamese Tin, Siam	57	56	55
South Crofty (5s.), Cornwall	4	15	14
Tekka, Malay	57	65	65
Tronoh, Malay	30	29	30

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

BOSTON CREEK GOLD DEPOSITS, ONTARIO.

Bulletin 29 of the Ontario Bureau of Mines contains descriptions of the Boston Creek and Goodfish Lake gold districts, written by A. G. Burrows and P. E. Hopkins, assistant provincial geologists. The accompanying map shows the relative positions of these mining centres and also those of Kirkland Lake, Larder Lake, and Sesekinika. Boston Creek has a station on the Timiskaming & Northern Ontario railway, 45 miles northwest of Cobalt, and 382 miles by rail north of Toronto. Claims were staked in the Boston Creek area in 1906 and 1907 during the Larder Lake rush, and interest was revived in 1913 during the Kirkland Lake boom. But the geologists had known the district many years previously, and had recognized the rocks as likely habitats of gold. For instance a survey had been made in 1872 by Walter McOuat, Willet G. Miller was there in 1900, W. A. Parks in 1904, and M. E. Wilson in 1908 and 1909. The pioneer of the present operations is John Papassimakes, whose company is the R.A.P. Prospecting Syndicate and is working the Kenzie vein. Joseph McDonough discovered a deposit to the southeast in 1915 that is being developed by the Miller-Independence company. Between these two properties is the McRae. Other prospects are the Connell-McDonough, Cullen-Renaud, Authier-Charlebois, and the Charest. Particulars of the R.A.P. and Miller-Independence are given later in this paper. At the time the report was written no bullion had been shipped.

Boston Creek area has an elevation varying from 700 to 1050 ft. above sea level, and the station has an elevation of 920 ft. The difference in elevation is seldom more than 200 ft., and the country is rugged and broken, particularly near the station and along the north branch of the Blanche river. The country is south of the continental divide, and is drained by two branches of the Blanche river and their tributaries, which flow southward into lake Timiskaming.

The rocks are all Pre-Cambrian, the nearest younger formation being an exposure of Niagara limestone about ten miles to the south. The rocks of the area may be classified as follows:

Keweenawan.	Quartz diabase dikes.
	(Intrusive Contact).
Algoman.	Felspar porphyry and quartz porphyry, hornblende and biotite granite, and syenite.
	(Intrusive Contact).
Timiskamian.	Conglomerate, greywacke, and slate.
	(Unconformity?)
Keewatin.	Grey schist (volcanic fragmental rocks and iron formation). Ellipsoidal, amygdaloidal and spherulitic lavas, agglomerate, tuff, iron formation, serpentine, diabase and felsite. (These rocks are in part altered to hornblende and chlorite schists.)

The Keewatin rocks have the widest distribution, and are important as they contain gold-bearing veins. They consist chiefly of greenstones with some volcanic fragmental rocks and iron formation. A band of clastic sediments is mapped as grey schist. The original constituents are so entirely altered that many exposures may be spoken of as serpentine, hornblende and chlorite rocks. Cutting the greenstones is a felsitic rock which may be post-Keewatin in age.

The greenstones are fine grained, and consist of altered basic volcanics which are sometimes schistose, but more often massive. They commonly show the amygdaloidal and ellipsoidal structure, and more rarely the spherulitic, indicating their volcanic origin. The spherulitic structure, which is rare in basic rocks, has not been noted before in this section of Ontario. What may be the spherulitic structure in greenstone was reported on the north shore of Doig lake in the northwest corner of Lebel township. A similar structure was also seen under the microscope in an acid rock, a rhyolite, from Beatty township. Spherulitic greenstones are beautifully developed on a bare hill in Boston township. The varioles, which are rounded and white-weathering, vary in size from minute pea-like form to those about two inches in diameter, and constitute a large part of the rock. Under the microscope the varioles consist of coarse radiating flakes of chlorite, felspar, epidote, and probably quartz, in a fine groundmass of the same material, and actinolite. Throughout the whole rock are pyrrhotite grains and numerous black ferruginous specks. The rock is probably an altered basalt.

The pillow lava flows constitute the main portion of the greenstone. They are interbedded with much non-pillow greenstones, which have a diabasic texture at times, and some tuff, agglomerate, and slate, which point to a subaqueous origin. The nearly complete alteration of the greenstones, with the retention of their original ellipsoidal structure, is, according to Leith and Van Hise, due to a metasomatic rather than a dynamic change. Under the microscope the original minerals in the greenstones are hornblende, quartz, magnetite, and plagioclase, the altered plagioclase laths suggesting a basaltic or diabasic texture. The secondary minerals are calcite, hornblende, chlorite, sericite, and quartz. The altered greenstone in places may be spoken of as hornblende or chlorite schist.

In the volcanic fragmental rocks, tuff and agglomerate are prominent, particularly in the northwest corner of Catherine township. They are, in places, interbedded with the basic volcanics. They are somewhat similar to the grey schists described below, but are much intermingled with the greenstones.

Iron formation, consisting of interbanded silica, black slate, and magnetite, occurs in the greenstone in the north part of Boston township.

One of the trails in Boston township passes over an exposure of serpentine. This consists of about 60% of serpentine and 40% of calcite. Numerous magnetite grains and a little pyrite are scattered through the rock.

A belt of banded, greyish-green schist resembling an altered sediment occurs on the periphery of a granite and syenite mass, passing in a semi-circular shape through Boston Creek station to Round lake. The schist approaches a vertical attitude with a strike parallel to the periphery of the granite. A great portion of the series consists of narrow alternating bands of rusty carbonate (including some magnetite and pyrite bands) and slate. Ash rocks, with bomb-like inclusions, are common. The whole series is greatly metamorphosed by the large granite mass, and is cut by narrow porphyry, lamprophyre, and other dikes.

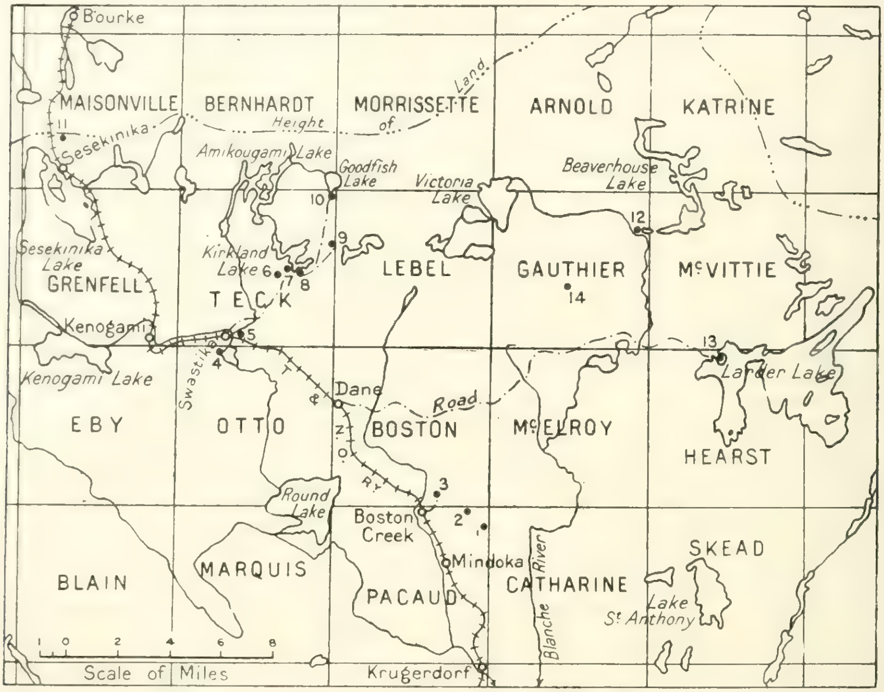
In the southwest part of McElroy township, and running north-westward across Boston township, are small areas of a white-weathering, felsitic-looking rock which may be post-Keewatin in age.

Quartz diabase dikes are rare in this area; however, they were noted cutting the greenstones and Timiskamian (?) sediments. These dikes are classed as Keweenawan, as they are fresh-looking and resemble the diabase at Cobalt.

Gold, the chief mineral sought in the area at the present time, occurs usually native, but occasionally combined with tellurium in quartz veins and veinlets in the Keewatin greenstone and later intrusions of granite and porphyry. The veins, which have a varying strike and dip, are well mineralized with varying quantities of pyrite and molybdenite, and sometimes with chalcopyrite, galena, specular hematite, bismuthinite, gold, and a telluride. The gangue consists largely of quartz of several generations, with considerable calcite and chlorite. The gold is found along the dark streaks of chlorite and calcite.

There are various types of gold deposits: (*a*) Fissure quartz veins in the greenstone and porphyry, with well-defined walls, as at the Miller-Independence, McRae, and Authier. (*b*) Replacement veins; the country rock, including altered greenstone and porphyry, has been brecciated and partly replaced by vein-forming solutions of quartz of several generations, and by calcite and other carbonates; example, the Kenzie vein on the R.A.P. property. (*c*) A stockwork in granite and porphyry.

As pointed out by W. G. Miller and C. W. Knight in a paper called 'Metallogenetic Epochs in the Pre-Cambrian of Ontario' (a précis of which appeared in our issue of December last), most of the gold deposits of Ontario belong to the Algoman epoch. The gold deposits of Boston Creek supply another example of gold being derived from acid intrusives of Algoman age. The granite, syenite, and felspar porphyry exposed in this area by erosion are probably different facies of a plutonic rock which underlies the whole area. The gold generally occurs near these acid rocks. The presence of a number of gold-bearing veins along the contact of the intrusive porphyry and older rocks at Boston Creek, as in many other parts of central Canada, and the frequent occurrence of auriferous quartz veinlets in the porphyry and granite, suggest the relationship between the intrusives and the veins. The relationship is more clearly shown in this area by the occurrence of gold in a pegmatitic vein in the granite on the Charest claim. The deposits are in part due to the replacement of the country rock by mineral solution. Some minerals which characterize deposits that are formed at high temperatures are found in the veins at Boston Creek. Actinolite was noted in a thin section of material from the Kenzie vein, and specularite has been frequently observed in other veins. Other minerals formed at high temperature, such as pyroxene,



MAP OF PART OF ONTARIO, SHOWING POSITION OF BOSTON CREEK AND GOODFISH LAKE.

apatite, and tourmaline, have not been noted. It is probable that the deposits were formed at great depth, but not at extremely high temperature.

The R.A.P. Prospecting Syndicate owns a number of mining claims in the area. The Kenzie vein occurs in a massive pillow lava. The vein, which has been stripped for about 400 ft., strikes 30° north of east and dips from 60 to 70° to the south. It varies from several inches up to five feet in width, with good breaking walls on either side. Spectacular gold showings were obtained from a 28 ft. shaft on the western end of the vein and finely disseminated gold can be seen in many samples on the dump. When the property was visited by the authors in May 1916, the easterly inclined shaft had reached a depth of 135 ft., and 230 ft. of driving on the vein had been done on the 100 ft. level. Development has shown the ore to occur in shoots in the vein. The vein material consists of quartz of several generations, silicified rock, reddish calcite, and brecciated and partly replaced masses of reddish felspar porphyry. The occurrence of felspar porphyry in various parts of the workings suggests that originally the greenstone was intruded by a narrow felspar porphyry dike which at a later period was greatly brecciated, and impregnated with vein-forming solutions which carried the gold and other minerals. The gold occurs with a very fine-grained greenish quartz, which has the character of a replacement deposit, while the green colour is due to minute inclusions of chlorite. Iron pyrite is finely disseminated in the vein, and copper pyrite, molybdenite, and galena occur in minor quantity. Certain parts of the vein run as high as $25 or $30 in gold to the ton across five feet. The property is equipped with a small plant, including a 60 h.p. boiler, 2-drill compressor, and hoist.

At the Miller-Independence, the vein has been traced for about 600 ft. in an east and west direction, and for several hundred feet easterly into Catherine township. It is narrow, averaging about a foot in width, and has a low dip to the north, usually about 20° or less, at one place being almost horizontal. The vein material is milky white quartz, and the mineralization is more or less concentrated toward the foot-wall side of the vein. Telluride, copper pyrite, pyrite, specular iron ore, and galena are observed in the quartz. Native gold occurs frequently with the telluride and other minerals in a net-like arrangement in the quartz along the foot-wall. There are probably several tellurides, but so far only one, a bismuth telluride, containing some selenium, has been recognized. This telluride of a brilliant grey colour appears to occur abundantly with the gold. The country rock is mainly fine-grained pillow lava, associated with which is a coarsely grained basic rock of a hornblendic type. Along the vein there is a dike of grey felspar porphyry which at two places is two feet wide on the hanging wall side of the vein. The porphyry was also observed on the foot-wall side. It contains much calcite and other carbonates, as well as disseminated iron pyrite, and is cut by veinlets of quartz. The vein has been prospected by means of a number of trenches and pits, from which some high-grade ore has been bagged. At the time of the authors' visit a shaft was being sunk to the north of the vein. The property is equipped with a small plant, including boiler, compressor, hoist, and a Nissen stamp; and a small oil-flotation plant was being constructed.

GOODFISH LAKE GOLD DISTRICT, ONTARIO.

As mentioned in the paper on Boston Creek, Bulletin 29 of the Ontario Bureau of Mines, by A. G. Burrows and P. E. Hopkins, contains a description of the Goodfish Lake gold area.

Goodfish Lake is 1025 ft. above sea level, and is two miles northeast of Kirkland Lake. Gold was first found on the Costello claim in the summer of 1912, shortly after the discovery of gold on the Tough-Oakes mine, 2½ miles to the south. During 1915 considerable prospecting was done around the lake on the Costello, Martin, Brennan, Gibson, Potvin, Papassimakes, and other claims. All had ceased work at the time of the authors' visit in April 1916 except the La Belle Kirkland mines. Here underground mining was being continued on the Gibson-Potvin claims.

The Keewatin is the oldest and most dominant of the rocks, which are all Pre-Cambrian in age. The Keewatin rocks consist of pillow and amygdaloidal lavas and altered diabases in about equal volume. Some of the rocks are massive, while others are schistose and rusty, striking easterly and dipping vertically. The original constituents are largely altered, mainly to calcite, chlorite, and sericite, and often the rock is so greatly metamorphosed that there is no clue to its original nature. Cutting these older rocks are dikes, stocks, and flow-like masses of granite porphyry (quartz-felspar porphyry or rhyolite porphyry). The porphyry has a grey colour, and a whitish weathering surface in which white quartz phenocrysts ¼ in. across are conspicuous. Under the microscope the rock is holocrystalline. In the Kirkland Lake and Swastika report the quartz-felspar porphyry was classed as Keewatin on account of the fact that a conglomerate, on the north shore of Gami lake, classed as Timiskaming, was found to contain fragments of quartz-felspar porphyry similar to the porphyry which occurs near at hand in place. There is a possibility that this small isolated area of conglomerate is of later age than the Timiskaming, in which case the quartz-felspar porphyry might be of Algoman age, similar to the felspar porphyry around the Tough-Oakes mine.

The rocks of the area are mostly massive and schistose greenstones, cut by small irregular masses of schistose quartz-felspar porphyry. Gold, the chief mineral sought, occurs in narrow quartz veins and replacement deposits along the contact of porphyry with other rocks. The veins or stringers are generally an inch or less in thickness, but there may be a series of them forming a lode deposit. Often two or three parallel slip planes coated with quartz and a thin film of molybdenite may form the orebody. The large amounts of molybdenite and pyrite give the deposits a dark and rusty appearance. Visible gold, in a state of fine division, occurs in many parts of the area. A telluride has been reported to occur in Morrisette township, but no such mineral has been identified in the laboratory of the Bureau of Mines. Calcite and other carbonates occur with the quartz. The quartz-felspar porphyry appears in some way to have influenced the gold deposition as similar porphyries have done in Porcupine; and it seems also to have been the source of the gold-bearing solutions. If the porphyry is the source of the ores and is Pre-Timiskamian in age, then the gold deposition of Goodfish Lake is of an older type (Keewatin or Laurentian) than the Kirkland Lake gold-telluride deposits, which are clearly connected with the Algoman intrusions of felspar porphyry.

The cessation of work at many properties would suggest that many of the deposits are low-grade. At the La Belle Kirkland mines, the only property being worked at May 1916, considerable ore has been blocked out.

La Belle Kirkland Mines Limited operates a group of claims to the south of Goodfish Lake. On the most important the company has sunk a shaft to the 300 ft. level. The ore deposit occurs along the contact of quartz-porphyry and basalt. The porphyry lies to the north, and forms the hanging wall of the deposit, which occurs in the altered basalt. The shaft, which inclines 60° N. for 80 ft., and 70° N. below this level, is on the dip of the orebody, which is also approximately the angle of contact of the porphyry and basalt. The basalt near the contact is greatly altered to a greyish rock high in silica, calcite, and other carbonates. In this altered basalt area there are streaks or bands of blackish material which form the higher grade portion of the deposit. These streaks contain films of molybdenite, to which the dark colour is due, and abundant iron pyrite, quartz, and calcite, while visible gold is occasionally seen. A dark band near the footwall was persistent in the shaft, while other bands toward the hanging wall are more lenticular, but have similar characteristics to the foot-wall streak. The silicified material between the streaks or bands carries low values in gold, but the values obtained in the high-grade streaks, which vary from a part of an inch to a foot in width, have indicated that the deposit is workable over a considerable width. The management is at present continuing the sinking of the shaft and driving and cross-cutting at several levels to determine the size of the orebody. The narrow high-grade streaks or bands are reported to carry from \$20 to \$150 per ton in gold, while a probable value of from \$15 to \$18 per ton is given for a width of 7 to 10 ft. for some of the ore. The deposit is evidently a replacement of the basalt near the contact with the porphyry. There is no evidence of the filling of open fissures with milky white quartz. Slickensides surfaces in the material of the streaks indicate some faulting along the dip of the deposit.

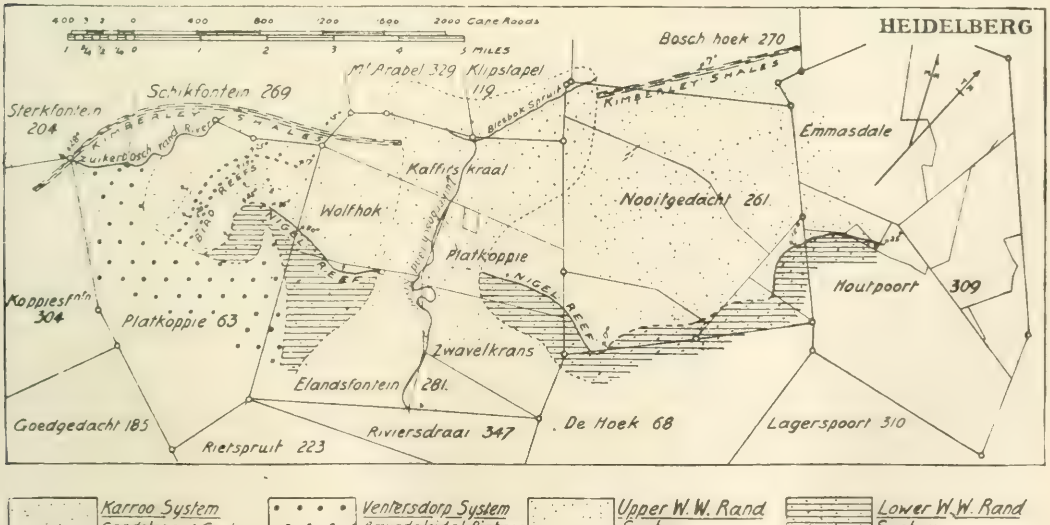
ASBESTOS MANUFACTURES IN CANADA.

The Associated Boards of Trade of the Eastern Townships of the Province of Quebec, Canada, have adopted a resolution urging the Quebec Government to enforce the utilization of the asbestos produced in the province in home manufactures and to prevent its wholesale export as at present. The Canadian Mining Institute, in its August *Bulletin*, advises caution in the consideration of such a policy. The resolution adopted by the Eastern Townships Boards of Trade was based on a number of assertions which it is not by any means certain can be accepted unconditionally. It was argued that Canada supplies approximately 80% of the world's requirements in respect of asbestos; that although Russia and Italy possess asbestos deposits, they are relatively small and the product cannot be marketed or used advantageously without mixing with the Canadian product; and that therefore Canada is in a position to control the asbestos market of the world; and this being so it is obviously to the advantage of the Dominion to exercise this control by prohibiting the export of asbestos except in a manufactured form and thus force manufacturers to erect their plants in the Eastern Townships. The situation is far from being so simple, nor is the interpretation of the facts, as set out in the resolution, an entirely dependable one. While it is true that Canada is at present the principal source of the world's supply of asbestos, there is no reason to suppose that it will be able to maintain that advantage if restrictions should be imposed that would compel foreign manufacturers to seek elsewhere for their raw materials. Russia, for example, has very important resources, which so far have been little exploited. The same is true of South Africa, while extensive undeveloped deposits are known to occur on the Island of Cyprus. Incidentally it may be mentioned that the Italian asbestos is of an entirely different character from that of the three principal producing countries and need not, therefore, be taken into account. Meanwhile, if the Canadian statistics are analysed, it will be observed that the greater proportion of the production of asbestos, roughly 80%, is low-grade material, known as mill stock and mill fibre, ranging in value from about \$9 to \$45 per ton, the average being between \$21 and \$22 per ton. On the other hand the production of Nos. 1 and 2 crudes, or the really high-grade asbestos, which in normal times are worth from \$200 and over per ton, is only 4% of the total output. It would be impossible, therefore, for the mines to operate if they were unable to market the short fibres or low-grade product, the bulk of which is sold in the United States, and used in the manufacture of inexpensive fire-proof construction material. Material of this kind consists of a mixture of cement and asbestos, in the proportion of 85% of the former to 15% of the latter. Hence, even if other conditions were favourable, the heavy freight charges on such material if manufactured in Canada for export trade would undoubtedly be prohibitive. But apart from this, directly any restrictions were placed on the exportation of the Canadian asbestos as mined, the present customers for this product in other countries would be stimulated to exploit other sources of supply, while no doubt Canada's best customer, the United States, would also, for the protection of the established manufacturing interests there, proceed to put in force retaliatory measures imposing prohibitory import duties on all manufactures of asbestos.

The idea that foreign asbestos is only marketable if mixed with Canadian fibre is an entire misconception. As a matter of fact Russia, prior to the war, produced just as much if not more high-grade (No. 1 crude) as Canada, while the Russian Nos. 3 and 4 crude command in normal times a price of about \$80 a ton f.o.b. Riga. For the best class of cement shingles, this latter product, in the proportion of from one-third to two-thirds, is mixed with the inferior Canadian mill stock, and not in the reverse proportion as sometimes supposed. Cyprus asbestos is also used as a sweetener for the Canadian fibre. Again competition from South Africa is not to be ignored. The exports from that country to Europe last year were over 5000 tons of Cape blue and Rhodesian white crudes. The former is undoubtedly of inferior quality to Canadian for certain purposes, but nevertheless has a large market. The Rhodesian white is, however, of excellent quality, and is now being employed to the exclusion of Canadian asbestos by the most important firm of textile manufacturers in England. It costs less to produce, as labour in Rhodesia is plentiful and cheap, averaging only a shilling per day, as compared with the minimum wage of \$2 per day paid to workmen in the Eastern Townships. In brief, while none will question the desirability of the establishment of asbestos manufacturing in Canada, this certainly cannot be accomplished by the drastic means advocated by the Eastern Townships Boards of Trade.

DEVELOPMENTS IN THE HEIDELBERG DISTRICT, TRANSVAAL.

The latest prospecting work in the Heidelberg district of the Transvaal is that which is being done by the Platkoppie Syndicate under the direction of John Moffat. The property under test consists of the three farms, Platkoppie 63, Nooitgedacht 261, and Elandsfontein 281. Dr. G. S. Corstorphine has recently made an examination of these properties and has written a report. The *South African Mining Journal* for August 5 and 12 publishes extracts from this report. The area in question is situated to the southwest of Heidelberg and the Nigel group of gold mines. The author describes the general geology of the district, which is shown in the accompanying map. He refers to the difficulties experienced in earlier years with regard to the correlation of the beds and auriferous reefs in the various parts of the Witwatersrand and outlying districts, and points out that even now the connection between the Nigel reef and the chief gold-bearing reef of the Far East Rand is not universally accepted. Proceeding to describe the work of Mr. Moffat, he states that several reefs have been traced through the farms Nooitgedacht, Elandsfontein, and Platkoppie, and that on the two last-named the reefs here been exposed by trenching and by prospecting shafts. There is some old prospecting work on Nooitgedacht and on the northern portion of Elandsfontein, but the continuation of the Nigel reef on the southern part of Elandsfontein and on Platkoppie is exposed for the first time in the present prospecting work. This means that four miles of unprospected outcrop has been added to the stretch previously known and partly prospected. Owing to a patch of Karroo sandstones on Elandsfontein, there is not a continuous outcrop of the reef and its associated beds along the entire line, but the section of Witwatersrand beds north and south of the covering of Karroo beds is the same, and there can be no doubt that the reef opened on the southern part of Elandsfontein is the same as the one to the north. On Platkoppie as well as on Elandsfontein and Nooitgedacht there is additional evidence of the reef being in the same geological position as the Nigel reef. To the west lies a ridge of Elsburg quartzite and conglomerate. Then follows another series of quartzites and reefs with underlying slate where the Kimberley Series should be expected. Between this and the workings are some small pebble reefs in quartzite which may be correlated with the Bird Series; then there comes the chief reef of Mr. Moffat's workings resting on slate with one or two thin reef or leaders above. On Platkoppie there is a hill of quartzite behind the prospecting camp, and on the south ot the hill slates outcrop, but then the amygdaloidal diabase appears taking the place of the greater part of the Lower Witwatersrand Series. It is, therefore, not possible to get much evidence for the correlation of the reef with the Nigel reef or Main Reef Series from the local outcrops of the lower division of the system. Though there would be a certain satisfaction in the existence of a complete section below the reef as well as above it, the absence of the former does not invalidate the correlation. All along the line of reef outcrop there is a broad exposure of foot-wall slates lying between the reef and the diabase. In no part of the line followed does the reef rest directly on diabase. On Platkoppie, the reef begins on the south-west at the contact of the Witwatersrand beds with the amygdaloidal diabase. The outcrop bends round the contour of the hill at Mr. Moffat's camp, and turns eastward into Wolfhok and then into Elandsfontein, where it is lost underneath the Karroo sandstones. It is next seen on Platkopje, part of Elandsfontein, whence it continues with an easterly strike into Nooitgedacht. On the western part of Elandsfontein, the reef has been exposed by trenching along its strike, while here and there a short cross-cut has been driven, to expose the underlying slate, or make certain that the trenches are close to the contact between the quartzite and slate. The reef as exposed along the outcrop consists of medium-sized pebbles in a sandy matrix. It varies from a thin line of pebbles to a bed 6 to 8 in. thick. The work has so far been directed to tracing the course of the reef, and proving the neces-



Geological Plan of Platkoppie, Nooitgedacht, and Elandsfontein, in the Heidelberg District of the Transvaal.

sary evidence for its correct correlation. Now that these two objects have been attained, the next step should be to prospect for gold content. In the reef of the Nigel mines, as well as in the Far East Rand, the gold values are sporadic, occurring in defined shoots. The further prospecting of the outcrops on Nooitgedacht, Elandsfontein, and Platkoppie should be directed toward discovering the possible existence of such shoots. In the accompanying map the course of the Nigel reef is shown, and also that of the Bird reef horizon and the marker band of Kimberley shales.

RECENT DIAMOND DISCOVERIES IN THE TRANSVAAL.

Much was made a few months ago in the local press in South Africa of new discoveries of diamonds in the Pretoria district of the Transvaal, not far from the Premier mine. At the time, the information available was scanty, and the value of the deposits could not be judged. An account of the occurrence is given by Dr. P. A. Wagner in the *South African Mining Journal* for July 15.

The Kameelfontein diggings are about sixteen miles northeast of Pretoria, and east of a bush-clad eminence known as Kameelkop. They are in the valley of an unnamed tributary of the Pienaar's River, which drains the depression among the felsite hills on the farm Elandsfontein No. 85 in which the Premier mine lies. Work has been done at different times on the diamondiferous alluvium found at intervals along the course of this stream, and Kameelfontein itself has on several occasions been the scene of fairly extensive digging operations.

Three types of alluvial deposit occur at Elandsfontein. These are: (1) Thin washes of diamond-bearing gravel in the present stream bed; (2) Elongated patches or runs of gravel occupying former channels of the stream and situated in close proximity to its present bed; (3) Ancient high-level gravels covering terraces situated at some distance from and at elevations of up to 120 ft. above the stream.

In the present instance work is practically confined to an ancient terrace, lying to the north of the river, on which, as a result of promising finds, the owner of this portion of the farm some time ago fenced off an area of about 40 acres. This was sub-divided into claims, measuring 45 by 45 ft., which were leased to diggers at the rate of £2 per month. The digger had, in addition, to take out from the Mines Department a monthly prospecting license, costing 2s. 6d., as owing to the fact that the farm was not proclaimed, the diggers on Kameelfontein had, in the eyes of the law, the status of prospectors. Water was delivered on the claims at a cost of 6d. per large barrel, and a charge of 1s. per head was made for fire-wood. All the claims within the fenced area were taken up, and 250 white diggers, employing over 300 natives, were at work. Encouraged by his success the owner threw open another block of claims to the west of the fenced area, and it is said that the ground to the north of the diggings will also shortly be offered on lease. For the guidance of prospective diggers it may be pointed out that the gravel exposed on the new claims, west of the fenced area, does not look very promising, while that to the north of the diggings is almost everywhere covered by a considerable depth of barren overburden, in addition to which disadvantage the gravel appears to become poorer in this direction. It is doubtful, therefore, whether either of these areas will yield anything like such good results as the fenced-in ground.

The terrace, on which the diggings are situated, has along its inner margin, 120 yards to the north of the river, an elevation of about 40 ft. above stream level. From here it rises steadily toward the north, and at the northern boundary fence, 600 yards from the river, its elevation is about 100 ft. It consists of a sloping platform of Waterberg sandstone and conglomerate on which lies a layer of coarse river wash of variable thickness, which in turn is overlain, as a rule, by fine ferruginous gravel and reddish brown surface soil. The Waterberg rocks strike from northeast to southwest, and dip at a fairly steep angle to the northwest. The surface of the beds of sandstone and conglomerate, on which the coarse gravel rests, is uneven and hummocky, with numerous deep pot-holes and gullies. In addition, the outcrops of the harder beds of sandstone clearly acted as efficient riffles, and the conditions on this particular terrace appear altogether to have been favourable for the lodgment of any heavy particles carried down by the stream. It is scarcely to be wondered, therefore, that a concentration of diamonds should have taken place upon it. The coarse river wash from which the bulk of the diamonds are recovered forms a persistent layer varying in thickness from a few inches to over 15 ft. in some of the deeper pot-holes and gullies. The average thickness for the whole fenced area is probably between two or three feet. It is composed of large boulders of sandstone and quartzite, for the most part well rounded, and smaller pebbles of sandstone, shale, and white quartz set in a clayey or lateritic matrix of reddish brown colour. The larger boulders appear to have been derived mainly from the disintegration of the underlying conglomerate, and it is thus clear that it is a mixture of eluvial and alluvial material. In the concentrate obtained on washing the sifted gravel there were noted small fragments of ferruginous shale, banded ironstone, non-magnetic iron ore, and occasional rolled grains of ilmenite. There is nothing in the nature of the wash to indicate the propinquity of a kimberlite pipe. The coarse gravel, as already stated, is, as a rule, overlain by a bed of fine ferruginous gravel known locally as the Kaffircorn layer. This has also been found to carry diamonds in places, but the results obtained from its exploitation have, on the whole, been disappointing. The Kaffircorn layer is in turn generally succeeded by red surface soil.

The average weight of the diamonds found on the Kameelfontein diggings during June was 0.83 carat, and the average value £3. 6s. 9d. per carat. The largest diamond recovered weighed 37 carats and was valued at £300. The best stone found weighed 12½ carats and was worth £316. Recently some fine 7 and 9 carat stones have been obtained. The diamonds are, on the whole, of poor quality. Well-formed crystals are comparatively rare, and broken stones and cleavage fragments preponderate. Heart-shaped twin crystals are occasionally found. While some fine white and blue-white stones are found, the majority of the diamonds are characterized by a more or less pronounced brown or yellow tint, and several pale green stones were also noted. Many of the diamonds exhibit the peculiar opalescence so characteristic of the Premier mine, and as regards crystallization, colour, and purity, etc., all the stones seen could be matched in the Premier parcels. There can be no doubt, therefore, that the Kameelfontein diamonds, for the most part at any rate, have been derived from the denudation of the Premier pipe. It may be argued against this view that the average value of the Kameelfontein diamonds is much greater than that of the Premier stones, but it must be remembered in this connection that the diamonds found in the yellow ground of the Premier mine were much better than those from the blue ground, and also that at the mine a much larger proportion of very small stones is recovered than at Kameelfontein. Other primary deposits may, of course, have contributed, but as already pointed out there is nothing to indicate the proximity of a kimberlite occurrence.

SECONDARY ENRICHMENT.

As our readers are aware, the chemists and petrologists of the geophysical laboratory of the Carnegie Institution at Washington have been conducting researches into the many problems of secondary enrichment of sulphides. These studies are conducted in co-operation with the professors of the Harvard mining school and with the assistance of several of the American copper companies. An important paper embodying the result of experiments undertaken with a view of ascertaining the effects of the various sulphides in causing precipitation is published in the July-August number of *Economic Geology*. It is entitled 'Some Reactions involved in Secondary Copper Sulphide Enrichment,' and the authors of the paper are E. G. Zies, E. T. Allen, and H. E. Merwin. For the benefit of those who are not geologists, the authors briefly outline the principle of secondary enrichment as applied to copper - bearing pyritic ore. When such an ore is exposed to oxidizing influences near the earth's surface, copper and iron sulphates and sulphuric acid are formed; much of the iron is concentrated near the surface as hydrous iron oxide; the copper and iron sulphates and sulphuric acid pass downward in solution. The copper is eventually precipitated from the solution by the unoxidized sulphides below, and at the expense of these sulphides. The authors' researches show that the state of combination in which the copper is deposited is found to depend on the nature of the precipitating sulphide as well as on the composition of the solution. This conclusion was obtained after lengthy trials in the laboratory with various sulphides, namely, chalcocite Cu_2S, covellite CuS, bornite Cu_5FeS_4, chalcopyrite $CuFeS_2$, pyrrhotite Fe_7S_8, pyrite FeS_2, zinc blende ZnS, and galena PbS. We give in the following paragraphs a synopsis of the results in the laboratory experiments.

In all cases a copper enrichment product was obtained, either a sulphide, or in special cases metallic copper and cuprite. In all cases also it was found that the sulphate of the metal contained in the original sulphide was formed, and usually sulphuric acid as well, this sulphuric acid being derived from the oxidation of the sulphur in the sulphide with cupric sulphate $CuSO_4$. In these reactions cupric sulphate acts as an oxidizing agent, not only at elevated temperatures but at lower temperatures also. The enrichment products were crystalline and adhered firmly to the attacked sulphides, as in nature. When cupric sulphate was the enriching agent, pyrite was altered to covellite and chalcocite. Pyrrhotite was altered to chalcopyrite and probably to bornite, but the reaction was difficult to follow quantitatively owing to the variation in the composition of pyrrhotite. Chalcopyrite altered to covellite and chalcocite, bornite to chalcocite, and covellite to chalcocite. Blende and galena were altered first to covellite and subsequently to chalcocite.

The order of stability of the enrichment products toward cupric sulphate solution is: Chalcopyrite, covellite, chalcocite; each of them changing into the succeeding sulphide by the further action of cupric sulphate. Chalcocite, the most stable of all, may be finally converted into metallic copper and sulphuric acid, though very slowly even at 200°C.

As regards variations in the effects with temperature, in the main the rate rather than the nature of the reaction was found to be changed by raising the temperature. There were, however, a number of secondary reactions, negligible at low temperatures, which became pronounced at higher temperatures. Thus ferrous sulphate was partly changed into ferric sulphate by cupric sulphate. Also hydrolysis caused the formation of hematite, cuprite, and metallic copper. Experiments indicated that enrichment proceeds faster in the presence of cuprous sulphate Cu_2SO_4 than in the presence of cupric sulphate. It was found that an increase in the strength of the sulphuric acid retarded the enrichment of chalcopyrite and pyrite, but the enrichment of galena, blende, pyrrhotite, and bornite was accelerated. The influence of ferrous sulphate in the enrichment reaction is at first to increase the quantity of cuprous sulphate in the solution and, therefore, to accelerate the reaction, but this effect is soon lost unless the ferric iron formed is removed.

ZINC AND ITS COMMON IMPURITIES.

Now that high-grade zinc is so greatly in demand for brass suitable for munition making, the consideration of other metals often or usually accompanying the commercial brands is of particular interest. The American Society for Testing Materials has issued a report containing a section relating to the various grades of zinc and the effect of various accompanying metals on its quality. This section has been prepared by G. C. Stone, chief engineer of the New Jersey Zinc Co., W. H. Bassett, and M. N. Price.

For galvanizing, the effects of the common impurities are not very great. Iron is objectionable as it causes a loss in dross and makes the coating more brittle and liable to crack and peel off. Lead, up to the limit found in commercial zinc, has no serious effect, but it is objectionable when present in large quantity, as it liquates in the bath and does not enter the coating and is, therefore, wasted. Lead is usually worth less than zinc and the purchaser does not wish to pay for it at zinc prices.

In alloys, aluminium is frequently injurious, 0·01% in many cases making brass useless for the purposes for which it is intended. In the few instances where its presence is desired in alloys, it is more satisfactory to add it separately than as a constituent of the zinc.

Iron is always present in commercial brands, but is undesirable in brass and similar alloys, as it makes them harder and greatly increases the hardness due to cold working. The increased hardness is objectionable, causing a greater consumption of power and endangering the rolling mills and drawing presses.

Lead is objectionable in some alloys and allowable in others, and the main variation in the different grades of zinc is in the permissible amount of lead. High-grade zinc, used for alloys that are to be subjected to the most severe spinning and drawing operations, should be rejected if it contains over 0·07% of lead, as the lead reduces the ductility of brass. 'Intermediate' zinc, with a lead limit of 0·2% is used for alloys that do not have to undergo as severe treatment, and also largely for alloys like manganese bronze that are used both cast and wrought. A brand called brass special, has a lead limit of 0·6%, and is mainly used for brasses where the maximum ductility is not required. The lead and iron are limited to 0·6% and 0·03% respectively. Selected zinc carrying the maximum of 0·8% of lead and 0·04% iron is used by brass manufacturers for making alloys to which lead is added in order to obtain free cutting qualities. Material of this kind is usually made into rods and heavy sheets for the manufacturing of small articles by turning, milling, and drilling operations. Such brass must contain sufficient lead to reduce the strength of the material and cause the chips to break easily. Owing to the fact that brass is usually made in crucibles in small quantities, uniformity in the zinc is of the greatest importance. As lead segregates badly, and more markedly the higher the proportion, the lead limit of the average sample is made low enough to allow for this tendency without injurious effect on the product. Even when the brass manufacturer adds lead, he does so in known amounts and thus obtains a uniform alloy from the different pots, which would not be possible if all the lead needed were contained in the zinc.

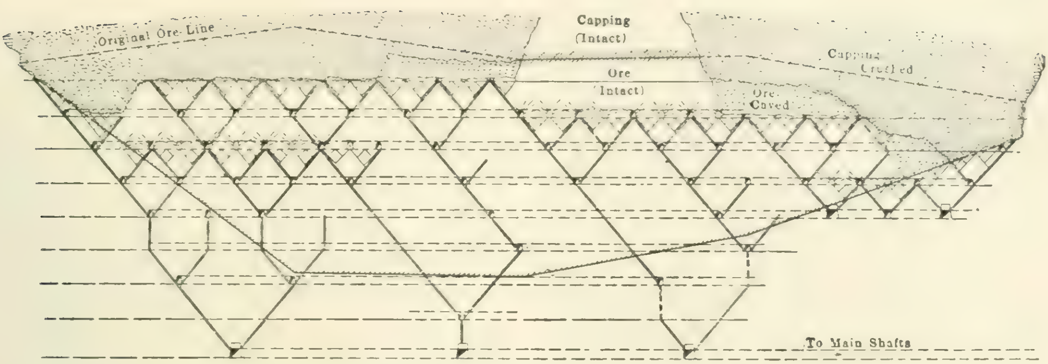
There is little doubt that cadmium in zinc is injurious for some of the purposes for which it is used, as it renders it harder and much more brittle. There is, however, considerable difference of opinion as to how far these undesirable properties persist in alloys made from zinc containing cadmium. The majority of the brass makers are of the opinion that the high temperature of the brass pots causes so much of the cadmium to volatilize that the residual amount has little deleterious effect. There is no doubt that large amounts of cadmium, say 1 or 2%, make brass hard and brittle. There is no reliable information at present to show the effect of small amounts of cadmium on the alloys, and the evidence on this point is extremely conflicting. Cadmium, together with lead, seems to intensify the effect of the latter, and also causes the brass to become more sensitive to the effect of overheating in the various annealing operations to which the wrought material is subjected. Little zinc is made containing as much cadmium as is allowed for intermediate and brass special, and the Society's specifications put practically no limit on cadmium except for high-grade. Whatever the facts may be for alloys, it is certain that the amounts of cadmium allowed by the specifications are much greater than are permissible for other purposes for which zinc is used. The question of cadmium in the better grades is complicated by the fact that until the last year and a half practically all the high-grade and most of the intermediate zinc produced in America was made by one company from ores that are free from cadmium. The American alloy makers have, therefore, no extended experience with the effect of cadmium in the better grades of spelter, and during the last 18 months conditions have been so abnormal that it is difficult to draw conclusions. High-grade zinc is extensively used for galvanizing telegraph and telephone wires, which are required to stand sharp bending when making the 'lineman's splice,' as it has been found that if impure spelter is used, the coating cracks and peels off the joint. The only high-grade zinc that has been used for this purpose is entirely free from cadmium. As cadmium is the element most likely to cause this trouble, it is doubtful whether metal containing as much as is allowed by the specifications (0·05%) would be suitable for this purpose. For rolling, cadmium causes such severe cracking that metal containing much of it is not economical.

In the above paragraphs we give the views of the American Society of Testing Materials on the influence of impurities on the qualities of zinc. Another paper on the subject was presented at the meeting of the Institute of Metals in September by W. R. Ingalls, editor of the *Engineering and Mining Journal*. We quote from his remarks in the following paragraphs.

For some purposes for which zinc is used, the presence of cadmium, even a small percentage of it, is deleterious. For brass that is to be cast and machined, the bad effect of cadmium is probably over-estimated, and it may not be adverse at all. For cartridge brass, it is objectionable. In many cases where cadmium is objectionable, it is not unlikely that there are unnecessary hair-splittings about hundredths of a per cent. Military engineers and others who specify respecting brass should look carefully into this. The differences in price that have lately prevailed, and still do to a less extent, between what in America are classified as high-grade, intermediate, brass-special, and common spelter are quite extraordinary. The sampling of spelter is more or less of a haphazard process, and has a bearing on this subject. American brass-makers follow a time-honoured practice of sampling a carload (about 50,000 lb. of spelter in 820 to 960 slabs) by drawing 10 slabs at random, and that practice has received the official endorsement of the American Society of Testing Materials. Mr. Ingalls gives instances of the unreliability of this method, and concludes that if it is continued, either of two things must be done : (1) Sellers in offering a guarantee should specify as to whether it pertains to average of a carload or to any 10 slabs selected at random ; (2) if buyers must have uniformity, smelters must ensure it by pouring and mixing their product in large pots or melting furnaces before casting the slabs.

In America brass-special spelter is made by reserving the first of the three daily drawings of spelter. This metal, having been distilled before the furnace has attained its maximum temperature, is relatively low in lead, but in it there is a concentration of cadmium, which being volatile at a lower temperature than zinc comes over chiefly in the first stage of the distillation. Theoretically it should be possible to control the temperature of the distillation so as to cut off both the cadmium-bearing spelter and the lead-bearing spelter, obtaining a high-grade spelter between, but in practice that would be quite out of the question. It is, however, easily possible to get a high-grade spelter low in cadmium, by the redistillation of common spelter with proper control of the temperature and separation of the first distillate.

The electrolytic process of zinc extraction affords an easy means for the separation of cadmium. But the electrolytic process will be commercially applicable only under limited specially favourable conditions and will not drive zinc smelting out of the world's arts. However, the electrolytic zinc production that is likely to endure should go a long way toward meeting the demand for high-grade spelter and especially spelter low in cadmium. And, furthermore, inasmuch as the electrolytic cathodes have to be remelted in large furnaces, the slabs cast therefrom should be more uniform in composition than those coming from the small tapping kettles of the retort furnace.



THE CAVING SYSTEM AT INSPIRATION COPPER MINE.

Mining Methods at Inspiration.—In a paper published in the September *Bulletin* of the American Institute of Mining Engineers, G. R. Lehman describes the method of mining adopted at the Inspiration copper mine, Arizona. This orebody is big and of low grade, and being fully developed, a cheap wholesale method of mining could be adopted. After much experiment, it was decided to adopt a modified system of caving. The necessary shafts had been sunk. Haulage drifts were driven under the ore at intervals of 100 ft. Then short rises were started every 25 ft. along each drift. From these short rises, inclined rises were driven at an angle of 50° in a plane at right angles to the haulage drifts. As these inclined rises progressed, other levels were commenced at intervals of 35 ft. vertically. When the height convenient for the commencement of the first undercut was nearly reached, inclined rises were started at opposite angles, and intermediate drifts commenced on the top level 25 ft. apart. These drifts were connected by cross drifts at intervals. At the top level, caving was commenced by blasting the pillars between the longitudinal drifts. The broken ore falls down through the rises, after being broken to pass 1 ft. openings. The illustration herewith fully explains the method of operation.

Manganese Ores in Bukovina.—In our issue of May last we gave an outline of the present position of the combatant nations with regard to the supply of manganese ore. We mentioned that Germany and Austria had no longer access to the rich ores of the Caucasus, India, and Brazil, and that they would have to rely on their own resources of low-grade ores for the production of ferro-manganese, or more probably spiegeleisen, required for steel refining. The actual resources of such ores are not known in this country, and published information is scarce. A paper by H. K. Scott, presented at the meeting of the Iron & Steel Institute this month on this subject, is therefore of particular interest. He describes the manganese deposits in Bukovina which, though not of high grade, are richer than any deposits continuously worked in Germany or the Austrian Empire. These deposits are in the neighbourhood of Jacobeni, in the southwest of Bukovina, near the borders of Rumania and Hungary. They have been known for three-quarters of a century, but in the early days they were worked more for their iron content, and probably the metallurgical value of manganese was not fully known. An ironmaster, Manz von Mariensee, built three blast-furnaces at Jacobeni. He became interested in the district about 1850, and at his invitation Von Cotta made a geological examination. Manz got into difficulties, and the iron making business came to an end. In 1870 the property passed to the Bukovina Greek Oriental Church Fund, under whose auspices the mining of the manganese ore continued. Jacobeni was connected in 1902 by a branch railway with the main line from Bucharest to Lemberg, Cracow, and Vienna, and subsequently the output of manganese ore was increased. The average ore assays 33% manganese, and after the richer parts are removed by hand-picking, the remainder is crushed and jigged. The ore contains phosphorus, and the price of the concentrate is governed thereby. Previous to the war, the Witkowitz company, in Austrian Silesia, was a large buyer of the concentrate for ferro-manganese manufacture, and glass and chemical makers bought the picked ore. Just before the war, at the time of Mr. Scott's visit, schemes were in hand for the expansion of mining operations.

Antimony Ores in Rhodesia.—The Interim Report of the Rhodesia Munitions and Resources Committee contains information relating to the occurrence of antimony ores in Rhodesia. The gold ores in many parts of the territory contain arsenic and antimony, but stibnite is also found unassociated with gold. The auriferous antimonial ore occurs irregularly in quartz veins and schists, and it is of granular texture. Occasionally jamesonite, the double sulphide of lead and antimony, is found in finely scattered crystals, in association with the stibnite. The stibnite that does not occur with gold is found in veins and is distributed more regularly, and often is not accompanied by quartz. It then has the characteristic coarse-bladed structure. A good example of this type of ore is to be found at the Modern claim four miles south-east of Gatooma, where the vein was worked on the oxidized outcrop for gold without result; the mine is now being reopened for the purpose of working the stibnite below. It is not probable that in normal times any Rhodesian deposit could rely on stibnite alone. Stibnite is distributed through the central part of Southern Rhodesia, in a belt of country extending from Hartley to Belingwe, and from Gwelo to Selukwe, being found most abundantly around Gatooma, Que Que, and Lower Gwelo. In most of the mines it is only sparingly present, but it is occasionally found in patches and pockets, as at the Phœnix, Petrol, Motor, Do Me Good, Inez, and Faugh-a-Ballagh, where it can be picked or concentrated in a form suitable for export. Two shipments of antimony ore have been made recently. In one case the profit was little or nothing, and in the other the transaction resulted in a loss to the producer.

The Report quotes a letter and terms of contract submitted by H. A. Watson & Co., Liverpool, to the British South Africa Company in connection with the sale of antimony ore. This letter is dated April 18 of this year. The lowest percentage of metallic antimony in the ore to receive consideration is 50, though under special conditions a little lower might be acceptable at a lower price. Incidentally, it is interesting to note Messrs. Watson's statement that they are receiving thousands of tons of antimony concentrate from Bolivia.

The terms of contract submitted by Messrs. Watson are as follow: Price 11s. per unit less $2\frac{1}{2}$%. Draftage, 12 lb. per ton. Delivery, c.i.f. Liverpool or ex ship London at buyer's option, with the usual terms for these ports, destination to be declared later, name of steamer to be declared within one week of sailing. Payment, in case of London delivery, 14 days after delivery to barge, and, if prepayment is required, 14 days interest at 5% must be allowed; if Liverpool delivery, 14 days from sampling. Penalties for lead, up to 0·3% free, with an allowance to buyers of 5s. per ton of ore for every 0·1% over 0·3% up to $1\frac{1}{2}$%. Penalties for arsenic, 0·1% free, with an allowance to buyers of 7s. 6d. per ton of ore for every 0·1% in excess of 0·1% up to 0·5%. Should the ore fall below 60% an allowance to be made to buyers of 3d. per unit down to 55%; if below and down to 50% an allowance of 6d. per unit; if above 60% an allowance to be made to sellers of 3d. per unit. Brokerage 1%.

Meteoric Iron.—At the September meeting of the Iron and Steel Institute, a paper was presented by G. F. Zimmer on the use of meteoric iron by primitive man. It has been held by many authorities that, before the discovery of the reduction of iron ores, any iron implement employed had been forged from native iron or iron produced accidentally from ore. The suggestion that meteoric iron formed an early source of supply does not find universal support. For instance, Flinders Petrie says it could not be used as it is not malleable. Professor Gowland allows that it is malleable, but points to the difficulty of detaching pieces suitable for use. Mr. Zimmer has spent many years collecting evidence tending to show that meteoric iron was so used. He quotes Dana's statement that meteoric iron is perfectly malleable and Miers' opinion that meteors supplied most of the iron used by primitive people. He tabulates information relating to the constitution and physical characteristics of recorded meteorites, and shows that a largely preponderating proportion are malleable. He describes and illustrates many meteorites which are of such a shape that parts could be easily severed and flattened into blades, and he illustrates also a number of Eskimo tools that bear evidence of meteoric origin. The paper is a lengthy one, and is enriched with detail and references to other authorities.

Manufacture of Hydrogen.—In our issue of May last, we made short reference to papers describing methods of producing hydrogen. Since then a paper has been published in the June number of the *Journal of the Aeronautical Society of America*, written by H. L. Barnitz, and describing two types of electrolytic cells for the dissociation of water and the production of both hydrogen and oxygen. In these cells a 28·9% solution of caustic potash is the electrolyte, the alkali acting only as an agent in dissociation and not having to be renewed. The first of these is called the 'unit' type and is used by a number of firms, such as the General Electric Co., Cooper-Hewitt Electric Co., and the Edison Storage Battery Co. The cell measures 5 ft. 6 in. high by 3 ft. 9 in. by 1 ft. 9 in. With a current at 2 volts and 400 amperes the yield is 6·3 cu. ft. of hydrogen per hour and 3·2 cu. ft. of oxygen. This corresponds to 8 cu. ft. of hydrogen and 4 cu. ft. of oxygen per kilowatt-hour. The temperature of the operation is 30°C. The cell calls for no attention and never requires cleaning if distilled water is used. The second type is of larger size, and contains a series of parallel electrodes, thus gaining for itself the description 'filter-press' type. It is used at the United States Naval Aeronautic station at Pensacola, Florida. It is made in two sizes, one of them being 14 ft. 6 in. long, 8 ft. high, and 4 ft. 6 in. wide. This contains 60 bipolar plates, 36 in. square, with a voltage drop per plate of 2 volts, and a total of 120 volts and 320 amperes. The yield per hour is 280 cu. ft. of hydrogen and 140 cu. ft. of oxygen. The yield per kilowatt-hour is 7·5 cu. ft. of hydrogen and 3·75 cu. ft. of oxygen. The temperature of operation is 70°C. The gases produced are very pure. The bipolar plates are of nickel on the anode side and iron on the cathode side. The paper contains full details of the two types of plant, with practical hints as to their working.

TECHNICAL JOURNALS FOR THE MONTH

British.

Colliery Guardian.—*September 1:* Coal Mining under Lake Hakanoa and the Waikato River, New Zealand; Surface Plant at Brodsworth Colliery, South Yorkshire. *September 8:* The Coal and Bunkering Ports of Canada, F. J. Warden-Stevens; Electric Equipment in the Donetz Coal Mines, South Russia. *September 15:* Shaft-Sinking through Sea and Mud at Carriden Colliery on the Firth of Forth. *September 22:* Stone-dusting in Collieries, G. D. Budge. *September 29:* Coal Shipping at Southern United States Ports, F. J. Warden-Stevens.

Engineer.—*September 1:* The Elephant Butte Dam on the Rio Grande, New Mexico; Two Small Hydro-electric Plants in New Zealand. *September 8:* Drainage of New Zealand Swamps. *September 15:* Steam Storage Locomotives. *September 22:* Report of Committee on Glass Research; Salmon Creek Dam of the Alaska Gastineau Mining Co.

Engineering.—*September 1:* Tree-felling by Machinery. *September 8:* Housing and Feeding Employees at Vickers' Munition Works; The Mathews Elevator and Gravity Carrier for use in Machine Shops. *September 22:* British Association Committee's Report on Fuel Economy. *September 29:* A Liquid Pocket Compass; Discussion on E. A. Smith's paper before the Institute of Metals on the Development of the Spelter Industry, H. K. Picard, H. M. Ridge, Robert Mond, and others.

Imperial Institute Bulletin.—*April–June:* The Work of the Imperial Institute for India, Wyndham R. Dunstan; The Occurrence and Utilization of Nickel Ores; Sapphire-Mining Industry of Anakie, Queensland.

Institute of Metals.—*September 20:* Allotropy of Silver, W. D. Helderman; Cadmium in Spelter, W. R. Ingalls; Annealing of Arsenical Brass, C. H. Mathewson and E. M. Thalheimer; Development of the Spelter Industry, E. A. Smith.

Institution of Mining Engineers.—*September 14:* Permeability of Coal to Air or Gas, and the Solubilities of Different Gases in Coal, J. I. Graham; Form and Structure of the Coalfields of Scotland, David Ferguson.

Iron and Coal Trades Review.—*September 8:* Nationalization of Coal Mines, its Relation to Royalties, David Evans; Turbo Air Compressors for Collieries made by the British Thomson-Houston Co.; Electric Signalling with Bare Wires, S. F. Walker; Boilers heated with Coke-oven Gas. *September 15:* Report of British Association Committee on Fuel Economy; Gas Furnaces and their Utility, R. Hackett; Combating Water in the Buckley Collieries, Flint, W. Hopwood. *September 22:* Report of Proceedings at the Autumn Meeting of the Iron and Steel Institute. *September 29:* Sir Robert Hadfield's Scheme for Reorganizing the Iron and Steel Institute; Utilizing a Sullivan Coal-Cutter Motor for Driving Centrifugal Pumps at Aberaman Colliery on an unexpected inflow of water.

Iron and Steel Institute.—*September 21:* Manganese Ores of Bukowina, H. K. Scott; Use of Meteoric Iron by Primitive Man, G. F. Zimmer; and six other papers.

Midland Counties Institution of Engineers.—*October 7:* Pit-Timber and its Preservation, Professor Percy Groom; Carbon Dioxide as a Fire Extinguisher, with reference to its application at Senghenydd Colliery.

Royal Society of Arts Journal.—*September 15, 22, 29:* Surveying, Past and Present, E. A. Reeves.

COLONIAL.

Australasian Institute of Mining Engineers.—*No. 22, 1916:* Experiments in Connection with the Flotation of Gold-Copper Ores at Mount Morgan in 1913, W. Shellshear; The Estimation of Mineral Contents of Waters used at Mines for Battery, Leaching, Boiler, and other purposes, E. Broughton Jensen.

Australian Statesman and Mining Standard.—*July 13*: Molybdenum Industry in New South Wales, E. C. Andrews; Tasmanian Water Power, Hartwell Conder [continued July 20].

Western Australian Chamber of Mines Monthly Journal.—*June:* Effect of Lead Salts and of Varying Degrees of Alkalinity on the Solvent Power of Cyanide Solutions for Gold, H. R. Edmands, being additions to a paper published in the April issue.

Canadian Mining Institute Bulletin.—*September:* Nickel Refinery in Canada, R. W. Leonard; The Nickel Problem; The Production of Flotation Oils in Canada, Arthur A. Cole; Consumption of Coal in the Prairie Provinces, William Pearce; Mine Car Design, Marcus L. Hyde.

Canadian Mining Journal.—*August 15:* Ontario's Nickel-Copper Industry; Chief Minerals of the Sudbury Nickel Ores, A. P. Coleman; Origin of the Sudbury Nickel-Copper Ores; Recent Developments in the Sudbury District; Boston Creek Gold Area, A. G. Burrows and P. E. Hopkins. *September 1:* United States Exports of Nickel; Mineral Belt North of The Pas, Manitoba, J. S. De Lury; Biography of the late Edgar Dewdney, a pioneer in British Columbia.

Mining and Engineering Review, Melbourne.—*July:* The Mount Morgan Mine and Works [continued August]. *August:* Molybdenite, its Occurrence and Treatment in New South Wales, E. C. Andrews.

Queensland Government Mining Journal.—*July:* Queensland Mineral Deposits: Molybdenite, B. Dunstan; Rio Tinto Copper Syndicate's Mine at Montalbion, Irvine District, E. C. Saint-Smith; Mount Cannindah Copper Mine, Burnett District, L. C. Ball. *August:* The Malvern Tin Mine, Gurrumba, E. C. Saint-Smith; Tin and Wolfram Deposits at Robson's United Mine, Tinaroo, E. C. Saint-Smith; The Ipswich Coalfield, W. E. Cameron; The Asbestos Resources of Queensland, B. Dunstan.

South African Institution of Engineers.—*September:* Note on the Value of Annealing the Connecting Attachments of Winding Plants, J. A. Vaughan; Repairing a Large Valve-Chamber of a Pumping Engine by the Quasi-Arc System of Electric Welding, W. Ingham; A Pre-heated Blast Cupola, J. A. Parsons.

South African Mining Journal.—*July 29:* The Areachap Copper Mine, Cape Colony. *August 5:* Graphic Methods of Estimating Profits, Capital Required, etc., in connection with the Development of Deep Level Properties in the Far East Rand; Prospects of the Gold Mining Properties of the Platkoppie Syndicate, south of Heidelberg, G. S. Corstorphine [continued August 12]. *August 19:* The Proposed New Government Gold Mining Leases, at Brakpan and Modderfontein; the Water Supply of the Rand.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*September:* Geology of the Warren Copper District of Arizona, Y. S. Bonillas, J. B. Tenney, and L. Feuchere; Mining and Milling Methods at the Inspiration Copper Mine, H. Kenyon Burch; Mining Methods at the Inspiration Mine, G. R. Lehman; Cyaniding Clayey Ore at Buckhorn, Nevada, P. R. Cook; Possibilities in the Wet Treatment of Copper Concentrates, L. Addicks; Smelting at the Arizona Copper Co.'s Works, F. N. Flynn; Leaching Tests at New Cornelia, H. W. Morse and H. A. Tobelmann; Flotation in the Clifton-Morenci District, Arizona, David Cole; Flotation Process at Inspiration, R. Gahl.

Economic Geology.—*July-August:* Some Reactions involved in Secondary Copper Sulphide Enrichment, E. G. Zies, E. T. Allen, and H. E. Merwin.

Engineering and Mining Journal.—*August 26:* Testing Dredge Bucket Pins, with notes of ordinary carbon steels of suitable strength, R. A. Young; Diamond-drilling at Sudbury, Ontario, relating to the cost of operations and the necessity for surveying the holes, L. A. Parsons; Shanking Drill Steels, C. C. Phelps; Replacing Mortar Blocks, C. Labbe. *September 2:* The Empire Long-stroke Table, John Gross. *September 9:* The Patino Tin Mines, Bolivia, B. L. Miller and J. T. Singewald; Driving a 1200 ft. Rise at the Britannia Copper Mine, British Columbia, S. Ford Eaton. *September 16:* Concentrators for Iron Ore in the western part of the Mesabi Range, L. A. Rossman; Allen Automatic Classifier, J. W. Crowdus; Mining Magnetite Ore in Cuba, L. B. Reifsneider. *September 23:* Silver-Tin Mining in Bolivia, B. L. Miller and J. T. Singewald; Manganese in Tennessee, J. H. Watkins; Geological Relations of Sudbury Nickel Ores, C. W. Knight; A Cadmium Myth? by the Editor.

Franklin Institute Journal.—*September:* The Use of Powdered Coal in Metallurgical Furnaces, C. J. Gadd.

Metallurgical and Chemical Engineering.—*September 1:* Chemical Considerations concerning the Blast-Furnace, J. E. Johnson; Time Factor in the Formation of Aromatic Hydrocarbons from a Paraffin Base Oil, G. Egloff and T. J. Twomey; Notes on Copper Smelting at the United Verde Copper Co.'s Clarkdale Works, Arizona; The Active Materials and Electrolyte of the Alkaline Storage Battery, L. C. Turnock, *September 15:* The Selection of a Method of Ore Treatment, G. J. Young; Ostwald Process for Oxidizing Ammonia to Nitric Acid, F. C. Zeisberg;

The Metal Tie-Up in Electrolytic Refining, Lawrence Addicks; Sulphuric Acid Plant at the Donora Zinc Works of the United States Steel Corporation, T. N. Harris; Blast-Furnace Products, J. E. Johnson; Aluminium Castings and Forgings, F. E. McKinney.

Mining and Engineering World.—*August 19:* Function of Oil and Acid in Flotation, H. J. Stander; Reopening the Harqua Hala Mine, Arizona, once well known in London, W. P. De Wolf. *August 26:* Mining Possibilities in Colombia—VI., M. W. Alderson. *September 2:* Mining and Smelting at Casapalca, Peru; Advantages of Highly-Oxidized Red Lead, G. W. Thompson.

Mining and Scientific Press.—*August 19:* Surficial Indications of Copper, dealing with porphyry copper deposits, F. H. Probert; The Business of Mining, W. R. Ingalls; Continuous Ore-Sintering Machine, particularly for iron ores, P. O. Harding; *August 26:* An American's Impressions of South Africa, H. Foster Bain. *September 2:* Molecular Forces and Flotation, W. M. Coghill; Buying Supplies for a Mine, Nelson Dickerman; Tungsten in the Boulder District, Colorado, E. H. Leslie; Jig Concentration in Joplin District, Missouri, C. A. Wright. *September 9*: Construction and Operation of the Nevada Packard Gold-Silver Mill, H. G. Thomson; Concentration and Smelting of Vanadium Ore, R. L. Grider.

NEW BOOKS AND OTHER PUBLICATIONS

Ore Deposits, Vol. II. By Beyschlag, Krusch, and Vogt; translated by S. J. Truscott. Large octavo, 750 pages, 176 illustrations. London: Macmillan & Co. Price 20s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

The first volume of the English translation of this important work was published in 1914; the second appeared recently. The two together deal with all the known processes of ore formation and practically all the well known deposits of metalliferous minerals, and constitute a treatise on ore deposits that will doubtless rank for many years as a standard work on the subject. A third volume dealing with the non-metallic minerals of economic value, a group which is year by year playing a larger and larger part in manufacturing and consequently in mining enterprises, is contemplated by the authors, but has not yet made its appearance. A comprehensive work gathering together, condensing, and co-ordinating the scattered information relating to these minerals is much needed.

The authors classify ore deposits into four main divisions: magmatic segregations, contact deposits, cavity fillings and replacements, and ore beds. The earlier volume dealt with the first two of these divisions, and with so much of the third as concerned tin and mercury. The volume now issued deals with the remainder of the third division, and with the fourth. The cavity fillings and replacements include principally the young gold-silver and the old gold lodes, and the lodes and metasomatic deposits of lead-silver-zinc, iron, manganese, and copper; the ore beds comprise in the main the sedimentary deposits of iron, manganese, and copper, the auriferous conglomerates, and the tin, gold, and platinum gravels. Other deposits of minor importance are also included in each division.

Generalizations concerning each group precede the descriptions of individual occurrences. These often make excellent and very suggestive reading, and will probably appeal to the student interested in the theories of ore formation, in the discovery of principles likely to serve as guides in the exploration or opening up of orebodies, or in the development of mining properties, as the most valuable portions of the volume. The general remarks introductory to the young and old gold lodes, and to the lead-silver-zinc lodes may be cited as examples. The authors take care to point out, however, the danger of taking these generalizations as final, and the necessity of applying them with due caution in the case of newly discovered deposits.

The descriptions of individual occurrences, for reasons of space, have had to be made brief and concise. To those seeking detailed information many of them indeed may seem meagre and inadequate, but this defect is largely made good by the full references to relevant literature which facilitate the procurement of further information if required. As might be expected the deposits of Central Europe are dealt with in considerable detail, and many receive fuller treatment than deposits of much greater importance in remoter parts of the world. For example 13 pages are devoted to the andesitic gold ores of Transylvania, and 12 only to the auriferous conglomerates of the Witwatersrand. Again 13 pages are given to the description of the siderite lodes of Siegerland, Westphalia, while no reference whatever is made to the Wabana iron ore beds of Newfoundland, notwithstanding the fact that as far back as 1910 over a million tons of ore were exported from that basin, nor to the brown iron ores of Cuba of which half a million tons were raised in 1901, and nearly a million and a half in 1910. It is noteworthy also that no description is given of bauxite or laterite deposits, although these materials constitute an admirable illustration of a particular process of ore formation, and one of them already is, while the other may in the future become of great importance in the production of aluminium. Such omissions are, however, quite exceptional, and since the work was originally intended for German readers it is only natural that deposits near at hand in Europe should be more fully described than those at a great distance. The illustrations, of which there are a large number, are very helpful in elucidating the descriptions of the various fields and deposits.

The arduous work of the translator has been well done. Imperfections are few and far between, and it is difficult to find any but quite trivial grounds for criticism. The book makes smooth and clear as well as interesting reading, only occasional sentences, such as "marcasite occurs strikingly often . . . , while pyrite on the other hand recedes" (p. 720) revealing the characteristics of the original text.

The use of 'siderite' instead of 'chalybite,' though universal in America, is not common in this country, but it is as a matter of fact correct according to the rules of priority. This is not the case with 'sphalerite,' however, and many prefer to retain the older name 'zinc blende.' 'Pyrite' is rightly used instead of 'pyrites.' The latter is not specific and refers to any one of a number of minerals. It is questionable whether 'specularite' should be generally used for crystallized hæmatite, or 'spharosiderite' for concretionary siderite. If the various states of aggregation, in which particular minerals occur, are to be referred to by separate names, a great addition will be made to mineralogical and mining nomenclature without any very obvious advantage. 'Oxidation-metasomatism' does not seem a very suitable expression for replacement by meteoric waters, as opposed to hydrothermal and pneumatolytic metasomatism for replacement by deep seated waters and by gases respectively. 'Meteoric metasomatism' perhaps conveys the meaning better.

To the English reader, accustomed to interpret 'sq. m.' as square miles, the statement that the hæmatite deposit of Parkside in Furness "has a superficial extent of 60,000 sq. m." is startling until it is realized that 'sq. m.' in this case signifies square metres. At times metres is written in full, for instance, "the occurrence at Lindal Moor has a length of 800 m. and a thickness of 21 metres." It would have been better to adopt the latter plan consistently. An unconventional use of the hyphen is noticeable throughout the volume, for example, "clean lead- or clean zinc deposits" (p. 652), "lake- and bog ores" (p. 982), "tin-, gold-, and platinum gravels" (p. 1190), "metal- and mineral combinations" (p. 527). This unusual practice, intended to make for precision of meaning, may actually lead to ambiguity, as in the expression "copper- and lead-zinc ores" (p. 530). Departures from usage, for which there does not seem sufficient need, are also occasionally to be observed in the punctuation.

These criticisms, however, seem captious in view of the general excellence of what has been accomplished. English speaking students of mining geology owe a heavy debt of gratitude to the translator for his services in rendering the subject matter of such an important work readily accessible to them. He is to be congratulated on the successful completion of his difficult voluntary task.

The publishers have produced a worthy companion to the earlier volume. By using a thinner paper they make the second volume with 748 pages no more bulky than the first with only 514. A copious double index to subjects and localities referring to both volumes closes the work.

C. GILBERT CULLIS.

The Journal of the Iron and Steel Institute, Vol. 93, contains a report of the proceedings of the 47th annual meeting, held in London in May 1916. The address of the President, Sir William Beardmore, is followed by papers and discussions thereon: Influence of carbon and manganese on the corrosion of iron and steel, Sir R. A. Hadfield and J. N. Friend; Theory of the corrosion of steel, L. Aitchison; Relations between the cutting efficiencies of tool steels and their scleroscope hardness, J. O. Arnold; Initial temperature and critical cooling velocities of a chromium steel, C. A. Edwards; and four other papers.

YEARLY REPORTS OF MINING COMPANIES

Rooiberg Minerals Development.—This company was formed under Transvaal law in 1908 for the purpose of reopening ancient tin mines in the Rooiberg range of mountains, about 75 miles northwest of Pretoria. The company was floated by the Oceana Consolidated, but the control passed shortly afterward to the Anglo-French Exploration Co. Edward J. Way is consulting engineer and E. R. Schoch is manager. Operations started with a small experimental mill, and in 1912 a new mill was built consisting of 10 stamps, a tube-mill, tables, and slime-plant. The report for the year ended June 30 shows that 27,913 short tons of ore from the mine and 2974 short tons from the prospecting dumps was sent to the sorting station, and after the removal of waste, 28,133 short tons was sent to the mill. There was also treated 8258 short tons of accumulated middling and slime. The average assay-value of all the material treated was 3·02% metallic tin. The yield of tin concentrate was 1025 long tons, averaging 68·93% metallic tin. The assay of the tailing was 0·63% metallic tin, and the percentage of recovery was 77·95. The accounts show an income of £117,252, and a profit of £25,396. Out of this profit, £1502 was paid as taxes, and £900 was paid to the directors as special remuneration. The shareholders received £18,000, being at the rate of 10%. Out of last year's and accumulated profits, £9350 was spent on improvements. The development of the mine continues to give satisfaction. The sluicing of alluvial deposits overlying the lode formation has recently been started.

New Modderfontein Gold.—This company belongs to the Central Mining—Rand Mines group, and was formed in 1888 to acquire property in the Far East Rand. Milling commenced in 1892 with 10 stamps. In 1896 a new 60-stamp mill was built, and since then additions have been gradually made until the plant now includes 180 stamps and 7 tube-mills, and has a capacity of 50,000 tons per month. A second mill is under construction to treat ore to be raised through the circular shaft in the deep-level part of the property. The report now issued covers the year ended June 30, and shows that 758,107 tons was sent to the sorting station, where 16% of waste was removed, and 635,300 tons averaging 10·2 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 209,864 oz. and by cyanide 103,670 oz., being a total of 313,534 oz. worth £1,296,042 or 40s. 10d. per ton. The working cost was £546,925 or 17s. 3d. per ton, leaving a working profit of £749,117 or 23s. 7d. per ton. Out of this profit £71,842 was devoted to capital expenditure on plant and housing accommodation, and £60,814 was spent on development. Taxes absorbed £116,401. The shareholders received £455,000, the distribution being at the rate of 32½%. Development during the year has given excellent results in both the upper and lower parts of the mine. It will be remembered that a year ago the developments on the 11th and 12th levels in the lower part of the mine had not given good results and that, in consequence, 1,000,000 tons of ore was returned as 'probable' and not included in the reserve. On the 13th and 14th levels the conditions have been found much more satisfactory, especially as the distance from the shaft increases, both east and west. In the upper part of the mine, good results were obtained on the 8th, 9th, and 10th levels. The ore developed during the year amounted to 1,763,860 tons averaging 11 dwt. per ton. This does not include the 1,000,000 tons of 'probable' ore. The total reserve, excluding pillars, is now estimated at 7,477,390 tons averaging 8·5 dwt. per ton.

Nourse Mines.—This company was formed in 1894 as the Nourse Deep to acquire properties on the dip of the Henry Nourse mine in the central part of the Rand. In 1905 the outcrop mine was absorbed, as was also the South Nourse in 1909. The control is with the Central Mining—Rand Mines group. Mining operations are difficult owing to the unusual number of dikes and faults. The report for the year ended June 30 shows that 764,344 tons of ore was raised, and after the rejection of 13% waste, 663,490 tons averaging 5·9 dwt. per ton was sent to the mill. The yield of gold by amalgamation was 132,786 oz., and by cyanide 54,931 oz., being a total of 187,717 oz., worth £775,362, or 23s. 4d. per ton. The working cost was £661,159 or 19s. 11d. per ton, leaving a working profit of £114,203 or 3s. 5d. per ton. Owing to recent fall in grade, the scale of operations was expanded so as to reduce the cost per ton. During the year the tonnage treated was 61,540 tons higher than during the previous twelve months, and the cost per ton was 1s. 1d. less. On the other hand the yield per ton was 2s. 11d. less, and the working profit £43,840 less. Out of the profit £4042 was allocated to capital expenditure, and £12,942 was paid as taxes. The shareholders received £82,782, the rate being 10%. The ore added to the reserve was 499,100 tons averaging 6·6 dwt. Owing to the ore supplying the West mill becoming unprofitable, it has been decided to cease work there, and to concentrate on the Deep mill. The capacity of the latter has been increased to 50,000 tons per month. The ore reserve is calculated at 2,169,300 tons averaging 6·2 dwt. per ton, a fall of 783,100 tons and a rise of 0·5 dwt. as compared with the figures a year ago. The reason for these changes in the estimate is that several blocks of Main Reef ore have been eliminated from the estimate as unprofitable.

Eileen Alannah.—This company was formed in 1911 as a subsidiary of Willoughby's Consolidated to acquire a gold mine in the Gatooma district of Rhodesia, in the same neighbourhood as the Cam and Motor. The mine was previously let on tribute, and at the time of the formation of the company, the tributer's 10-stamp mill was taken over. The ore is refractory, containing arsenic and antimony, and an improved method of treatment had to be devised. During the design and erection of new plant, the old mill was kept at work so as to provide funds to help pay for the new plant. The report now issued covers the year 1915. This shows that the new mill, containing 12 Nissen stamps, 2 tube-mills, blanket concentrators, and cyanide plant for treating sand and slime, commenced work in June of that year. The total ore treated during the year was 45,978 tons, and the gold recovered was worth £97,101. The working cost was £56,297 including development redemption, and £9473 was written off for depreciation of plant. The net profit was £33,198, which, added to the previous balance, made a total balance of £52,832. Of this, £40,000 has been transferred to a machinery reserve account, and the remainder carried forward. The ore reserve is estimated at 186,130 tons averaging 10·6 dwt. per ton, as compared with 184,454 tons averaging 12·7 dwt. the year before. The fall in the average content is due to no development having been done, and the inclusion in the reserves of some blocks of lower-grade ore. During the year the Blue Duck and Egglantine claims have been acquired, and in this new property the reserve is estimated at 27,374 tons averaging 10·1 dwt. Since the end of December the profits have been sufficient to warrant the declaration of an interim dividend at the rate of 5% on a capital of £41,000.

Broken Hill Proprietary.—The half-yearly report now issued covers the period ended May 31 last. Owing to the prolonged strike of workers at Broken Hill, the operations were seriously curtailed, and only 66,423 tons of sulphide ore was raised, as compared with 114,579 tons during the previous period. At the lead concentrator 56,820 tons of ore was treated, producing 9352 tons of concentrate averaging 59·62% lead and 27·88 oz. silver per ton. In addition 26,929 tons of dump tailing was re-ground and sent to the mill, where 698 tons of lead concentrate was produced assaying 53·1% lead and 28·38 oz. silver per ton. At the zinc flotation plant 54,714 tons of material yielded 13,189 tons of concentrate averaging 45·95% zinc, 6·3% lead, and 12·8 oz. silver per ton. The flotation plant was closed on April 13, as the stock of zinc concentrate had become large and the sales were small. Since the end of the period under review the demand for zinc concentrate has revived and shipments have recommenced. At the iron and steel works at Newcastle, the output of pig-iron was 53,974 tons and the output of finished steel products was 36,862 tons. The coke oven plant is being extended from 66 to 99 ovens, and in March next should be producing at the rate of 200,000 tons per year. Four more open-hearth furnaces have been built or are under construction. Owing to the big demand for steel in Australia, the directors are discussing plans for doubling the blast-furnace and coking plant. The accounts show a gross profit of £398,191, out of which £32,036 was paid as debenture interest or placed to the sinking fund, and no less than £117,035 was placed to taxation account. The shareholders received £118,100, being at the rate of 25% for the half-year.

Renong Tin Dredging.—This company was formed in 1908 to acquire alluvial tin deposits on the Renong and Pak Chan rivers in the western states of Siam. The properties had been examined by E. T. McCarthy. Dredging was commenced in 1910, and two other dredges were added subsequently. These dredges have not given entire satisfaction, owing to their strength being less than is desirable and many repairs having been necessary in consequence. The profits were excellent in early years, but a year ago a loss was recorded. The report now issued covers the year ended June 30 last. Time continued to be lost on all three dredges owing to repairs required and the difficulty of obtaining duplicate parts. No. 1 dredge treated 570,546 cu. yd. for a yield of 270 tons of tin concentrate; No. 2 dredge treated 518,358 cu. yd. for a yield of 175 tons; No. 3 treated 734,615 cu. yd. for 382 tons. The total production was 827 tons, being a yield of just over 1 lb. per yard. The income from the sale of concentrate was £92,337, and the net profit was £30,745. After the extinction of the adverse balance with which the year began, £6875, and the payment of the accrued interest on the preference shares, £3750, there remained a credit balance of £20,119, out of which £3570 has been distributed as preference dividend at the rate of 15%, and £10,133 as ordinary dividend at the rate of 12½%. During the year £7500 debentures were redeemed by the issue of shares at 25s., and the outstanding debenture debt at June 30 was £10,500. F. W. Payne & Co. are the consulting engineers, and Frank Nicholls is manager.

Pena Copper Mines.—This company was formed in London in 1900 to acquire a copper and sulphur mine in the Huelva district of Spain that had previously been worked by a Belgian company. Small dividends were paid from 1903 to 1906, but subsequently conditions became less favourable. Then came a dispute with the Rio Tinto company over the selling and railway contracts, and capital had to be provided to finance an alternative route to the port of Huelva. During the construction of the railway, shipments were suspended. These were renewed in August 1914. The report for the year 1915 shows that 122,120 tons of ore was raised. Of this, 30,141 tons was delivered to the copper-leaching floors. The shipments during the year included 24,200 tons of cupreous ore, 65,802 tons of sulphur ore, 50,614 tons of washed ore, and precipitate containing 607 tons of fine copper. The net profit for the year was £42,641, out of which £27,955 was distributed as dividend, being at the rate of 6 per cent.

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EDITORIAL

GOVERNMENT inertia is proverbial. The Prime Minister announces that the adoption of the decimal system of weights and measures cannot be considered just now as it presents too many complicated problems. On the other hand, the Channel Tunnel project has received an uncertain amount of Government blessing, for we are promised an official reconsideration of the subject.

FACILITIES for the study of foreign languages at the universities in this country are rapidly increasing. We note with particular interest the foundation of a Chair of Spanish Language and Literature at Leeds University by Lord Cowdray. The firm of Pearson has extensive interests in Spanish America, of which the best known to mining men are those associated with Mexican oil and with Mexico Mines of El Oro. The same university has also benefited by the liberality of Sir James Roberts, of the famous Saltaire woollen mills, who has provided the funds for a Chair in Russian Language and Literature.

COMPARATIVELY little is known of the nature of the substances that give characteristic colourings to precious stones, owing to their existence in almost infinitesimal quantities. On the other hand, the dealers are fairly expert in the art of changing the colours by certain methods of treatment. Cloudy zircons can be made colourless and passed off as diamonds, and the yellow topaz can be given a beautiful pink colour. This question arises again in connection with the sapphires found at Anakie, in Queensland. Many of these stones are of unusually deep violet colour, appearing to be quite black by artificial light. Yet there was always a demand from Germany for this type of stone, and it is supposed that some process was employed there for modifying the colour. Recent experiments at the Imperial Institute tend to show that the transparency can be greatly increased by exposure to high temperatures, and the supposition is thereby confirmed.

AS the Institution of Mining and Metallurgy is engaged in urging reforms on the Government, Sir Richard Redmayne found that the dual role of president of the Institution and head of the Home Office Department devoted to mine inspection was an anomalous one, and he consequently resigned as president. The presidential duties for the remainder of the year will be discharged by Mr. Edgar Taylor. In our last issue we gave an outline of the Institution's proposals for the establishment of a Department of Minerals and Metals. Sir Richard Redmayne's address to the Institution last spring indicates that he is as ardent an advocate of reform as anybody.

THOSE in control of the Alaska Gastineau company have found, as recorded last month, that wholesale mining of their wide low-grade lode has given a much smaller extraction per ton than they expected. They abandoned selective mining owing to the difficulty of accurately sampling the big blocks. This class of deposit can only be satisfactorily sampled by bulk trials in the mills. Unfortunately under these conditions a great deal of valueless rock may be treated before the figures for the average content is obtained. When the mine was opened, a small pilot mill was employed to test the lode. We suggest that in working this class of lode, a pilot test mill is just as essential after starting the big mill as before.

FOR a "strong" committee that is really strong commend us to that recently established by the President of the Board of Trade "to consider the position after the war, especially in relation to international competition, of the lead, copper, tin, and other non-ferrous metal trades, and to report what measures, if any, are necessary or desirable in order to safeguard that position." Sir Gerald Muntz represents copper and brass, Mr. A. H. Wiggin the nickel alloys, Mr. Clive Cookson antimony, Colonel A. J. Foster lead; Mr. A. W. Tait is chairman of the British Aluminium Company, Mr. C. W. Fielding is chairman of Rio Tinto, and Mr. Cecil Budd, head of the firm of Vivian, Younger, & Bond, besides being interested in tin, may be said to be the representative of the London Metal Exchange. Such a committee has a vast power for good in connection with the future of the British metal trades. We would couple with this expression of our approval of the committee a hope that it will not forget the claims of the small producers of ores.

IN the Patents Court last month permission was granted to the Share Guarantee Trust, controllers of the Swansea Vale Spelter Works, to use the continuous process of zinc smelting outlined in British Patents 1338 of 1912, and 732, 6771, and 9314 of 1913, granted to Roitzheim and Remy, and used experimentally at the Grillo works at Hamborn, Germany. Attention was drawn in this country to the process by the article in the Magazine for July, in which the process is fully described. The royalty to be paid by the Share Guarantee Trust to the owners of the patents is 6d. per ton for the first 10,000 tons produced and 3d. per ton thereafter. The licence to use the process was not an exclusive one, and other zinc producers will be free to apply for similar facilities.

CHINESE mineral resources are gradually receiving more attention, and eventually the deposits in the southwestern states will come prominently before the public. But the time has not yet arrived, partly on account of the world war and partly because of the uncertainty of Chinese rule. In the meantime we have presented several articles from men who have intimate acquaintance with the country. In this issue, Mr. J. A. T. Robertson, a Canadian engineer now holding the professorship of mining and metallurgy at Cheng-tu, gives his impressions of southern Sze-chuan and eastern Yunnan. In our July issue, Mr. Herbert W. L. Way wrote on the minerals of Sze-chuan, and in the present issue, Mr. J. Coggin Brown confirms some of Mr. Way's opinions, and mentions the difficulty of differentiating between active and abandoned mines in the Chinese official records. In our issue of September a year ago, Mr. Gilmour E. Brown wrote on the Hunan tinfields, and in March of this year we gave quotations from a paper on antimony mining in Hunan, written by Mr. A. S. Wheler for the Institution of Mining and Metallurgy. Our pages therefore contain much information that will prove valuable to the future investigators of Chinese mineral resources.

IN another part of this issue we quote the main headings of the judgment in the case of Minerals Separation versus the Miami Copper Company, the point at issue having been whether or not the Callow flotation process infringes the Minerals Separation patents. The judge holds that Minerals Separation can claim as a novelty the use of less than 1% of oil. Notice of appeal has already been lodged by the Miami company. In another court two years ago, the judges when trying the case of Minerals Separation versus Hyde held that the amount of oil had nothing to do with the question, and that therefore the Minerals Separation patent was bad. The Hyde case has since been argued before the Supreme Court and judgment is expected shortly. These American judgments are just as nonsensical as the English and Australian judgments. As the judges usually know nothing about the subject in hand, it is a mere fluke which side wins the final round.

DE-TINNING of old cans collected from the dustbins is once more to the fore. The British De-Tinning Co., of Westminster and Birmingham, is about to undertake the work. As recorded in our September issue, the business of the London Electron Works Company, of Limehouse, which collected material to send to Goldschmidt's at Essen, has been acquired by the firm of scrap-metal merchants, George Cohen, Sons & Co. Neither of these firms has told us yet of the processes to be used. At Limehouse the cans used to be compressed into briquettes, which were treated at Essen by gaseous chlorine. The tetrachloride of tin thus obtained was sold at a high price to silk dyers, and profits were made that were not possible by any process recovering the tin as metal. The Limehouse-Goldschmidt process was described and its economics discussed in our issue of October 1914.

IN publishing articles by our professional friends, we have recently adopted the custom of adding short sub-titles explaining briefly the scope of the papers. These sub-titles are usually helpful to our readers. Unfortunately this is not invariably the case. The authors of "Winter Washing at the Lenskoi Mines, Siberia," Messrs. C. W. Purington and R. E. Smith, were not treated fairly when the Editor said in the sub-title that the gravel mined during winter is in the frozen state. As a matter of fact the gold gravel now mined at Lenskoi is for the most part unfrozen. Even when it is frozen, the thawing is done underground. The system of winter sluicing described by the authors was devised for the purpose of preventing the gravel becoming frozen after it is raised to the surface, so permitting its treatment immediately, instead of stacking it for treatment during the summer months. The procedure was clearly described by the authors, but we take this opportunity of correcting an inaccurate addition by the Editor.

State Mining on the Rand.

The relation of the State to gold-mining in the Transvaal, especially with regard to the future development of the deposits in the Far East Rand, is a question of vital importance, demanding an early solution. Discussion in the Legislative Assembly has been followed by the appointment of a Royal Commission, whose duties are to inquire into and make suggestions with regard to the advisability of State mining, the financing, organization, and control of State mines if such are created, and the legislative steps which would be required. The cable messages so far received indicate that the witnesses examined are not in favour of State mining, and we fear that, unless some definite scheme is advanced by an independent party, the Commissioners will leave the subject where they found it. It is obvious that the present bar to progress, caused by the difficulty of arranging terms between the Government and the financiers as to their relative shares in future profits, must be removed. It seems to us that the discussions so far have been too vague, and that both parties are holding back in the hope of the policy of drift working to their advantage. There is so far as we know no definite proposition before the State, the financiers, and the public, round which to centre a practical discussion. To remedy this position of apparent deadlock, Mr. Ernest Williams comes forward with a definite plan for the future development of the Far East Rand. We print his article in our Discussion column, and we urge our readers to ponder his suggestion carefully. Mr. Williams is well known as a sound engineer of wide experience in many parts of the world, including South Africa, and his views on this subject therefore merit due respect. Briefly stated, his suggestion is that the State should sink twin or triple shafts at some suitable central point and construct the necessary underground station; that these shafts should serve a wide area of ground far more extensive than any at present operated by any existing company; and that this area should be subdivided into sections suitable for exploitation by individual companies, these sections being connected with the shafts by main haulage-ways in the foot-wall country. The shafts would be sunk and the station constructed by contractors who would take payment in Government bonds. The ground would be leased in sections to such financial groups as are prepared to make suitable offers. With shaft-accommodation already provided, the preliminary capital outlay for each individual company would be greatly reduced, and the State's share in the profits could be arranged with greater satisfaction to the financiers. Engineering work more nearly approaching that found in the best civil engineering practice could be put into the shaft-sinking than is customary on the Rand, where rapid progress combined with low cost is the standard. Parenthetically Mr. Williams makes two points that are of considerable importance. One relates to the advantages of the concrete-lined elliptical shaft, and the other to the damage done to the walls of a shaft by placing the blasting holes too near. On a future occasion we may enlarge on these two points; it is inadvisable to do so now, for it might tend to take attention from the main suggestion.

Careful consideration of the proposed plan on our part has so far revealed no drawbacks. The capitalist would be relieved of much preliminary expense, and the reduction of risk thereby secured would release profits more readily and render the payment of a share to the State less onerous. The risk of failure, the chief bugbear to State mining, would be removed by a very large area being covered by the State enterprise, over which to average the gold content of the ground to be mined. It may be doubted by some whether the shafts could handle so great a tonnage of ore, but those who know the Rand are aware that the shafts of even the best mines are worked at far below their real capacity. By Mr. Williams' plan, therefore, the cost of underground transport and hoisting would be substantially reduced. We appeal to engineers and financiers interested in the Rand, and also to the State authorities, to study this proposal and to offer comment and criticism. At the same time we invite Mr. Williams to amplify his proposal and to enter into greater detail. The questions of ore treatment and power supply under the scheme will also require consideration, but these may be conveniently postponed for a future occasion.

The Excess Profits Tax Again.

Enough has been said in our pages on the general principle of the excess profits tax, and its unfair incidence on such mining ventures as are beginning to make profits, or are increasing their output for no reason connected with the war. The Institution's committee may be trusted to state the case of the mines to the best advantage in their communications with the Treasury, and to go as far as they dare without injuring their cause with the Government officials. With no such diplomatic restrictions to bind us we can go further than this committee, and demand entire exemption from the excess tax on profits from mines unless the increase can be directly traced to circumstances connected with the war. It is right that the owners of iron and coal mines should contribute out of their increased prosperity to the public funds, and the zinc smelters and producers of tungsten ores ought not to object to the principle of the tax; but why a gold mine that has just arrived at prosperity, or a tin mine where, owing to the cleverness of the management a valuable lode has been discovered, should be placed at a financial disadvantage is not clear.

This imposition makes it quite impossible to interest capital for organizing a new mining venture, or for placing a struggling company on a more satisfactory basis. We confess to a considerable sympathy with Mr. C. A. Moreing's campaign in Cornwall for the withdrawal of the tax as applied to local mines, and we may express a regret that the directors of other companies operating in the old county have given him no support. It is the old story of want of cohesion and co-operation among Cornishmen. Unless some immediate personal advantage is to be gained a Cornishman is hard to move. In this case it is fairly clear that no mine in Cornwall is likely to have any excess profits except East Pool, Mr. Moreing's own mine, so the others are not interested in the agitation.

A great many examples have been quoted of the hardships accruing to individuals and to companies under the new tax. The official interpretations of the Act and the official applications of its clauses are bewildering. A particularly hard case came to our notice recently. An engineer, who prefers to be paid by results at properties introduced and worked by him rather than realize his holdings on the Stock Exchange, has found his way blocked unpleasantly. He had introduced an excellent property to capitalists, who formed a company and provided money for development and equipment. For five years his share of the profits in the form of dividends averaged £5000 per year. On the exhaustion of this property he found another in the same region, to work which another company was formed. The result of the first year's operation promises to give him £5000 profit. On consultation with the revenue authorities he finds to his consternation that his new source of income will be subject to the excess profits tax, and that no comparison will be allowed between his income from the present source and his income from the previous source. The authorities hold that as the two ventures were or are operated under limited liability law each stands by itself, and that the profits of each individual company are taxed on their own merits without reference to the ownership of the shares. Thus, whereas two years ago he was paying only income tax on £5000, he now has to pay, on a similar income, excess profits tax as well, so that his total disbursement to the Treasury during the year will be about £3500. If instead of taking payment by profit he had acted as consulting engineer and manager to a succession of companies one after another, he would have had to pay nothing but income tax, and the excess profits tax on the various companies would not affect him in any way, even though his rate of remuneration increased with each appointment. Thus it will be seen that when an engineer takes his profits from results he is liable to far greater taxation than if he is paid a standing salary, so not only does he take greater risks in earning his living, but has to pay more dearly for it. This is one of the many anomalies of the present law. Judging by past experience, there is little chance for any amendment being made. For years the professional man who obtained an appointment in October had to pay income tax at the rate for unearned incomes, because the earned rate had to be claimed before the end of September. So it is hardly likely that he will obtain any sudden relief in the present case.

The Debt We Owe to the Elmores.

Amid the din of applause well enough won by the various American copper, lead, and zinc companies for their successful application of the principle of concentration by flotation, it is well that our memories should be jogged by the publication of Mr. Stanley Elmore's reminiscences in a recent issue of the *Mining and Scientific Press*. Fortune and the lawyers have treated the Elmores hardly. It is only fair to them that their pioneer work should be put on record and appreciated sympathetically. Only those who have followed the gradual steps by which practical progress was made, and a grasp of the physical and chemical forces involved was secured, can apportion the due credit to the various investigators and inventors. The American engineers who began to tackle the subject three years ago found everything plain sailing; their chief problem was to dodge the earlier patents; they forgot that fifteen years ago they or their predecessors had derided the whole idea. In early days, both in England and America, the pioneers were the victims of much contemptuous chaff for their bold assertion that heavy sulphide minerals could be made to float. When Mr. William Elmore, father of Stanley and Frank, exhibited a wide-stoppered glass bottle containing water, oil, and ore, and showed how, by rapid agitation and subsequent settlement, the sulphides were carried to the top by the oil while the gangue fell to the bottom, he was usually told, and not always politely, to seek an engagement at Maskelyne & Cooke's, for his legerdemain was too much even for the City of London. A similar mystification arose when the late C. V. Potter, of Broken Hill, demonstrated that zinc-lead sulphides could be separated from the gangue, when the ore was plunged into a strong acid bath, by means of the bubbles generated. Several eminent metallurgists and physicists argued that Potter's claim was radically absurd, because any gas liberated by the action of the acid from the surface of the sulphides must be sulphuretted hydrogen, yet the characteristic smell was admittedly absent. When subsequently the inventor explained that the gas liberated by the sulphuric acid was carbonic acid, that it came from the calcite gangue, and that afterward it attached itself to the sulphide particles, these authorities said that the explanation was far-fetched and therefore unworthy of credence. The present editor of this Magazine followed all the early work, and is well aware of the antagonism exhibited by engineers to a process that apparently upset all preconceived ideas of gravitation. Many readers may consider that our reference to the incredulity and suspicion with which the Elmore process was received in early days is an exaggeration. But those who are still comparative tyros in the matter exhibit the same caution. Thus it was necessary for our contemporary *The Engineer*, in its issue of November 3 of this year while reviewing the latest books on the subject by Messrs. T. A. Rickard and T. J. Hoover, to interpolate these disarming words: "A result which we freely admit savours at first sight of quackery."

Having said this much in defence of the early inventors, we may proceed to discuss a number of points raised in Mr. Elmore's paper. In the first place we wish to draw attention to the explicit statement made by Mr. Elmore, which is quoted on another page in our Mining Digest, relative to the origin of the Elmore invention. The circumstances certainly afforded reason for doubt as to the exact facts. Mr. William Elmore and his sons were previously keenly engaged in the electrolytic refining of copper and in the direct process for the production of copper tubes. In connection with this business, Mr. Elmore decided to acquire a copper mine, and purchased the Glasdir mine, near Dolgelley, North Wales. Mr. Frank Elmore, who was until then solely interested in electro-metallurgy and chemistry, went to the Glasdir mine to inspect the concentrating plant that had been erected, and during his visit he observed the fact that oil or grease, accidentally present on pipes and launders, attracted the sulphide particles and retained them. Thus he discovered for himself the selective action of oil for metals and sulphides. As we have said, he was quite a young man, and entirely inexperienced in mining and concentrating problems. It so happened that the previous operators of the Glasdir mine had experimented on a small scale on the action of oil as applied for the purposes of concentration, and the Robson & Crowder patent No. 427 of 1894 shows the methods employed. The experiments led to no practical results, and the apparatus was scrapped. It is a coincidence, which has been used to the utmost by the enemies of the Elmores, that Mr. Frank Elmore should receive his inspiration at the mine where an oil process had been tried previously. We can, however, believe that Mr. Frank Elmore, being as we have said, quite unacquainted with ore-dressing, made the discovery for himself. Mr. Stanley Elmore says he did, and in the absence of specific denial we accept his statement. Quite apart from the origin of Mr. Frank Elmore's idea, it is desirable to remember that his process was essentially different from that proposed by Robson & Crowder. The latter used large amounts of oil and mixed it with the ore, the amount of water employed being only sufficient to preliminarily moisten the ore. The sulphide particles were removed over the lip of the stirring vessel by means of a constant overflow of oil, and it was expressly stated in the patents that the amount of water should be limited. The Elmore principle was to use large amounts of water and to conduct the process continuously in a freely flowing pulp.

Having disposed of the main points of present contention, we may suitably refer to one or two other questions at present in dispute. It is said that only recently has the flotation principle been suggested for the recovery of gold from complex ores. This supposition is quite unfounded. A dozen years ago Mr. Hennen Jennings recommended that experiments should be tried on Rand ore, and careful tests were accordingly made by Mr. A. M. Robeson, who by the way is now in London serving with the Munitions Department. Mr. Robeson found that cyaniding the tailing after amalgamation did sufficiently well. Plants were erected at Lake View Consols at Kalgoorlie, at La Belliere and La Lucette in France, and at other mines in other parts of the world, but for various reasons the process did not prove advantageous. We do not say that, because these early applications did not prove profitable, the flotation process is not suitable for the treatment of gold ores, for in all probability in the light of later experience such an application will give excellent results; we only quote the examples mentioned to show that the earlier exponents of the principle were not unmindful of its possible benefits to the gold metallurgists.

In connection with the Elmore patents and with litigation with regard to flotation patents generally, it is suitable here to remark that the lawsuits, though prodigiously profitable to the legal fraternity, have no bearing whatever on the equity of the question as it appeals to the ordinary mining man. The Elmores were plaintiffs in England and Australia; Minerals Separation is plaintiff in America. The lawyers decide the grounds on which the actions are to be brought and the cases argued. The judges are bound to confine their attention to the evidence placed before them. With regard to the Elmore litigation, we never understood why the lawyers limited the plaintiffs' action to the original patent of 1898 and took no notice of the more important patent of 1904. It seemed obvious to the average engineer that the relative commercial failure of the 1898 process would weigh against the plaintiffs with the judges, whereas the success of the vacuum process based on the 1904 patent would have shed a beneficent light in the courts. As we have mentioned more than once in our columns, the Elmore process of 1904 discloses the use of small amounts of oil and in this way anticipates the Sulman-Picard-Ballot patent of 1905, which latter was used as the basis of claim in the United States litigation. Our other point in connection with flotation litigation relates to the status of the Callow process as used at Miami. Minerals Separation of course holds no brief for Elmores, otherwise it could urge that the Callow process is to all intents and purposes identical with the Elmore vacuum process. In both processes an expanding bubble, controlled by variation in atmospheric pressure, is employed for buoying the oiled particles of sulphide, and in both processes is the amount of oil employed small. In no lawsuit have these two vital points been introduced. We may suitably conclude by once more remarking that until the whole of the circumstances in connection with flotation are reviewed in one court, and by people having some knowledge of the actual requirements of the mining industry, no just apportionment of the rights and the recompense of the various contending parties will ever be effected.

Tanganyika Concessions.

In spite of a succession of serious obstacles, the copper industry of the Katanga has now been established on a sound business footing, and large profits are being made. When we use the words "sound business footing," we employ them only in their application to the Belgian controllers, and to Mr. Robert Williams, the pioneer of empire, who brought these copper deposits within reach of the European consumers of the metal ; for there are still many unsatisfactory conditions to be altered, conditions that can be traced to German aggression, or to the fear of German or German-American aggression, both before and after the war. With these few introductory remarks, we may suitably begin a review of the present position by recommending a careful perusal of Mr. Williams' speech to shareholders in Tanganyika Concessions, which is reported in full on another page. From this statement it will be seen that the Katanga smelter produced 14,190 tons of copper during 1915, and 16,749 tons during the first nine months of 1916. The number of blast-furnaces has gradually increased. A fourth and fifth were added in March and April of this year, and two more now on order should be completed about the middle of 1917. The furnaces put into commission this year are of larger size than those first erected, and measure 20 ft. by 44 inches internally. Their relative efficiency may be gauged by the fact that they have reduced the cost of producing copper to £22. 15s. per ton as compared with a cost of £27. 16s. at the old furnaces operating side by side with the new furnaces. So far during 1916 the average cost of the copper produced has been £25. 12s. per ton, to which must be added the cost of shipment to this country, £15. 19s. 3d., bringing the total cost per ton delivered in England to £41. 19s. 3d. The most important of these figures is that for the cost of producing in the new furnaces, for it affords a basis for estimating future profits when the charges for transport and other items fall to a normal level after the war. This copper has been sold for an average price of £102 per ton, so that profits aggregating two million pounds have been accumulated since the war began. These profits cannot be distributed at present, for the articles of association of the Union Minière du Haut Katanga provide that dividends can only be declared at a general meeting of shareholders held at Brussels. It is clear that no such meeting can be held under present circumstances. No legal method of varying the rule so as to release the profits for distribution has so far been devised. It was proposed at one time by Mr Williams that Tanganyika Concessions, holding 40% of the shares, and the Belgian Government, holding 35%, should agree to such a distribution, and to ratify the arrangement at the next general meeting of shareholders, but this proposal was not approved.

Since the outbreak of the war, the business of the Union Minière has been conducted under unusual conditions. The company was for suspending operations at the mines, but fortunately Mr. Williams' suggestion was adopted that they should be continued under the direction of Tanganyika Concessions. The funds and the books were locked up in Brussels, and the business was started in London without any capital. Copper was low in price and almost unsaleable, and had it not been for credits generously given by railway and shipping companies, by the suppliers of coal and coke, and by the employees, the industry would not have weathered the storm. The nature of the new contract for the sale of the copper made with Henry R. Merton & Co. has proved to be disadvantageous to the company, but as it was on much the same lines as the previous contract under which the copper was sold in Brussels, it is out of place to make comment. Moreover the disadvantage has only arisen recently owing to the increasing margin of price in favour of "best selected." In discussing this contract, it has to be remembered that sales of any sort were next to impossible, that the value of electrolytic copper for munition manufacture was not realized, and that though the copper was obtained from oxidized ores the presence of cobalt in these ores militated against a contract for its sale on the basis of "best selected." The cobalt constituent in the ore can in some places in the mines be separately won, but unfortunately there is no market for it at present.

An important point of Mr. Williams' statement relates to the treatment of the ores of lower grade. For furnace treatment it has been necessary to pick the ore to 15% or rather over, and the best way of dealing with the leaner ore has been under consideration for some time. Mr. A. E. Wheeler, the manager, now reports that it can be successfully treated either by concentration or by leaching, but he is in favour of leaching. In fact he says that he could produce copper by this method from the ore now being smelted at a lower cost than rules at present. In addition the copper so produced would be of improved quality. Mr. Wheeler is prepared to supply sufficient ore to a leaching plant to yield 50,000 tons of copper per year. The electric power would be obtained from waterfalls, according to a plan designed by the Swiss engineers several years ago, and we may assume that the acid required would be obtained from sulphide ore at the Luushia mine. The problem of financing the leaching plant will require consideration, and presumably the whole will not be built at once.

Mr. Williams also referred to the anxiety which he and the directors of the Union Minière experience lest the control of this great enterprise should pass to the Germans. Offers have been made to Tanganyika Concessions for years past from America and Germany for the purchase of control, but all such offers have been rejected. It is open to such intending buyers to secure control by buying shares in the market, and as the board has no legal means of stopping such transactions, an appeal is now being made to the Government for powers to keep the control of the enterprise within the empire. Mr. Williams cites a parallel case where Germans secured control shortly before the war of a British company operating in Portuguese East Africa, so that unless something is done in the meantime we shall find powerful German interests on the East Coast at the end of the war, and our military operations in that part of the world for the elimination of the German element will be rendered unavailing. Attempts were also made by the Germans to secure possession of the Benguella railway connecting Katanga with the Atlantic, which is under the control of Tanganyika Concessions, by offering to subscribe the capital for completing its construction, but this offer was rejected by Mr. Williams' company and the attack easily repelled, though here again the Germans may try to attain their object by buying the shares of the Benguella Railway Company. We heartily endorse Mr. Williams' demand that the Government should take some step to protect British and Belgian interests in Central Africa, and at the same time we congratulate him and his colleagues for so successfully piloting the enterprise through troublous times under most disadvantageous circumstances.

REVIEW OF MINING

Introductory.—No event of outstanding importance has occurred in mining circles this month. Mr. Robert Williams' account of the prosperity at Katanga relieved the minds of the any remaining doubters as to the soundness of the venture. Mexican misrule has made it necessary for the Exploration Company to write down its capital; we may hope that brighter days will make it possible to write up the capital at some future time, as was the case with the Wankie coal company recently. The Commission examining the advantages or otherwise of state mining in South Africa finds most of the witnesses averse to the proposal, but as yet no definite plan for state participation has been brought forward locally. In this connection we draw attention to an article elsewhere in this issue, in which a definite proposal is outlined. The metal markets have been without any feature of interest lately. The Government is taking tighter control and the authorities wisely deprecate undue discussion of conditions. For this reason we are curtailing our usual metal market reports, until such time as we are free to examine matters in intelligent detail.

Transvaal.—The output of gold on the Rand during October was 764,489 oz. and in outlying districts 27,850 oz., making a total of 792,339 oz., worth £3,365,642, as compared with 744,881 oz., 26,686 oz., 771,567 oz., and £3,277,408 during September. The number of natives employed on the gold mines at the end of October was 199,330, as compared with 197,734 at the end of September, and 210,017 a year ago. The number employed at diamond mines was 6358, as compared with 6527 at the end of September.

Last month we referred to the Government offer of the leases of two blocks of ground in the Far East Rand, one between Modder B and Rand Klip, and the other below Brakpan. It is announced that four tenders have been received for the Brakpan ground and five for the ground to the east of Modder B. The view expressed by us last month that a combination of Rand Klip with Cloverfield would form the best purchaser for the Modder block is shared elsewhere, for this plan, financed by the Central Mining and Investment, the controllers of Modder B, would appear to be generally acceptable.

The first periodical report from Daggafontein since the recommencement of operations states that the development footage was 1153, of which 692 was on the reef. The distance sampled on the reef was 645 ft.; the reef averaged 4·9 inches thick and assayed 37·79 dwt. per ton. Of the 645 ft. sampled 34·9% was in payable ground, averaging 72·26 dwt. over 5·9 inches. Sinking of No. 2 shaft 6000 ft. west of No. 1 has been commenced, and during the period 50 ft. was sunk and 34 ft. timbered.

Prospecting to the south of the South Rand dike at Crown Mines was commenced recently. A cross-cut was driven from No. 16 level at No. 7 shaft through the dike, and then a bore-hole was put out to determine the position of the reefs to the south of the dike. This has been completed, and the position of the reefs ascertained. Where the core passed through the Main Reef Leader, the assay-value was 900 dwt. over $2\frac{1}{2}$ in., while the South Reef assayed 21·5 dwt. over $5\frac{1}{2}$ in.

The Main Reef West mine continues to do badly, and for the third year in succession no dividend is paid. A year or more ago the debenture holders agreed to a postponement of the redemption of debentures for three years, so that funds should be available for active development. During the past year, only a half-year's supply of ore has been exposed. Every endeavour has been made to expedite development in the deep levels at both shafts in the hope of reaching a zone of better quality ore. In the meantime we may expect a further diminution in the working profits, owing to the reserve being of lower average gold content than it was a year ago.

As briefly mentioned in our last issue, Mr.

Percy Cazalet has reported on the chances of finding further ore at the Nigel mine in the Heidelberg district. Further details are now to hand. In the western section the main block of ground is practically exhausted. In the Rand Nigel section the indications are unfavourable to further work. East of No. 3 shaft conditions are more hopeful, though the ore shoots are narrower and less continuous than the main shoots. Mr. Cazalet recommends further exploration here, and the sinking of the incline shaft from 2000 ft. to 2500 ft. This work is estimated to cost £50,000 and to occupy a year, during which time the mill should be closed. If the ore continues in depth, it would be necessary to sink a vertical shaft, which would require still further funds. As no funds are forthcoming at present, development has been stopped and the reserves are being milled.

The diamond trade continues to increase in strength and the mines are receiving the benefit. So much so that the New Vaal River and the Jagersfontein companies have resumed the payment of dividends.

Rhodesia.—The output of gold during September was worth £322,035, as compared with £338,001 in August and £321,085 in September last year. The Globe & Phœnix has been able to declare an interim dividend for the current year, in spite of its huge law costs in the case between it and Amalgamated Properties. Mr. Justice Eve has not yet given his decision in this case.

The Shamva company has published Dr. G. S. Corstorphine's report on the geology of the mine. In this report he gives his own views as to the nature of the ore deposit. We have not space on this occasion for a full résumé of the report, and we shall have to postpone an adequate reference to the subject until December. We may briefly say that, in his opinion, there is no lode in the usual acceptance of the term, but that the gold is found in the weathered and softened parts of much jointed micro-granite, and is associated with calcite and other carbonates. In fact the orebody might be called a pipe. Dr. Corstorphine is of opinion that the termination of the ore on the 5th level is not due to faulting, and that the appearance of faulting is due to the jointed nature of the rock. Nevertheless he recommends cross-cutting to ascertain what has actually happened. He also has suggestions for prospecting at other parts of the surface for other orebodies, and for prospecting at depth.

West Africa.—The yield of gold during September was worth £127,138 as compared with £125,143 during August, and £159,410 in October 1914, the highest on record. But for the Ashanti gold mine recovering from the previous shortage of fuel, and Cinnamon Bippo increasing its output, the figures for September would have shown a decline, for the yields at Abbontiakoon and Prestea Block A both fell.

Gold-stealing is prevalent at the West African mines as well as in Rhodesia and West Australia, the conditions at which we have described recently. The directors of Prestea Block A have taken action in a London police court against one of their assayers for the illegal possession of $6\frac{3}{4}$ lb. of gold amalgam. The sentence was 6 months imprisonment.

The Berrida company was formed in 1912 to acquire alluvial tin ground in the Zaria province, Northern Nigeria, reports on which had been made by Mr. L. H. L. Huddart. After a short time Mr. J. J. Hunter, the manager, found that the tin content was too low for the ground to be treated at a profit. Other engineers have since confirmed his view, so the mine is to be abandoned. A new property has been taken on lease adjoining part of the ground of the Naraguta Extended to the north of the Delimi River.

Australasia.— Particulars of the Zinc Producers Association Proprietary Limited were filed at Somerset House last month. This company was formed at Melbourne in May last for the purpose of controlling the disposal of zinc and zinc concentrate produced in Australia. The various producers at Broken Hill are members of the company, as also is the Mount Lyell company, while opportunity is given for the Burma Corporation to join, which it should be able to do shortly. The first directors are Messrs. W. L. Baillieu, W. M. Hyndman, Montague Cohen, G. A. Grant, Bowes Kelly, Alexander Campbell, and J. L. Wharton, all of Melbourne, F. C. Howard and B. A. Moulden, of Adelaide, D. E. McBryde, F. A. Govett, F. A.

Keating, and W. H. Woodhead, all of London. The London office is at Pinners' Hall, where Mr. W. S. Robinson is in charge.

The Broken Hill Proprietary Company reports that the plant for treating slime by the Bradford selective flotation process has been completed and that trial runs are being conducted. In this process the zinc blende is made to float by frothing with oleic acid in water containing a sodium salt acidulated with sulphuric acid. The galena is wetted by this water, and does not take the oleic acid, thus falling to the bottom with the gangue.

The directors of Amalgamated Zinc (De Bavay's) announce that the electrolytic method of recovering zinc that has been investigated by Mr. H. W. Gepp is reported to be commercially sound, with power obtainable at £2 per horse-power-year. This is the price at which the Tasmanian Hydro-Electric Department is prepared to sell the power. It has been decided therefore to proceed with the erection of a first unit requiring 4000 h.p., calculated to have a capacity of 10 to 11 tons of zinc per day.

The hydro-electrical state enterprise in Tasmania continues to expand. In addition to the Great Lake station, another is to be erected at St. Clair Lake, which is much nearer the Zeehan and Mount Lyell districts. A calcium-carbide plant is being erected at Northwest Bay, by the Hydro-electric Power & Metallurgical Company. The first unit will have a capacity of 5000 tons per annum.

The Mount Elliott company reports, relating to development at the Dobbin mine, owned by a subsidiary, in the Cloncurry district of Queensland, that on the 3rd level an orebody has been struck averaging between 6 and 10% copper over 6 ft. The total width of the lode has yet not been ascertained. The company has decided to erect an electrolytic refinery of its own, and has already secured a site at Bowen on the coast. The smelting plant was closed in July, and is being rearranged. It is expected to start again in the new year.

Cornwall.—It is gratifying to hear that further funds have been subscribed for continuing development at the Geevor tin mine, near Land's End. As we have mentioned several times recently, the developments have lately disclosed ore of great promise. It will now be possible to make connection with Wheal Carne section.

The liquidator of the St. Ives Consolidated Mines, one of the late Schiff group, is endeavouring to raise additional capital by means of a debenture issue, in order to continue work at the Giew mine. The reopening is apparently to be done for the benefit of creditors, and we are informed that several local men are ready to subscribe. Ordinary and preference shares in a new company, of the nominal value of £40,000, are to be paid as purchase price to the liquidator, and it is proposed to raise £20,000 by the issue of convertible debentures, which will provide, after paying certain debts, £12,500 working capital. It is doubtful whether the property will stand this capitalization, but in any case it would be necessary to have the opinion of a mining engineer as to the condition of the property and its prospects.

Malaya.—The Fraser & Chalmers dredge at the Kamunting Co.'s ground in the Larut district of Perak is doing good work. During the past year the cost of treatment of 1,150,000 yards of gravel was £14,849, or 3d. per yard. The tin concentrate recovered, 621 tons, sold for £59,257, so that the yield per yard was worth 12·3d. If to the working cost is added London expenses, £1461, and provision for depreciation of assets and amortization of capital, £4473, the total cost per yard comes to 4·33d. The company deserves credit for adopting the sound business system of providing for the redemption of its capital. An insurance policy has been arranged whereby the whole of the present issued capital, £130,000, will be redeemed in the year 1931. Further particulars will be received with interest, for the company deserves full public credit for following this admirable course.

Statistics of current tin production in Malaya and Siam are difficult to obtain, because the various operators are controlled in different ways. Local workers, English companies, and Australian companies all contribute to the output. The English and Australian companies as a rule report their monthly yields. The Pahang Corporation is the largest individual producer, and the remarkable fact is that the tin is obtained from a lode mine, whereas the rest of the companies operate alluvial properties. The monthly output of the Pahang company's lode mine averages 220 tons of tin concentrate. The next highest producer is the Tronoh with a recent average of 140 tons per month, though a few years ago the average was as high as 300 tons per month. The Gopeng returns vary from 90 to 100 tons per month, the Tekka returns average 45 tons, and the Tekka-Taiping 50 tons. Of dredging companies, the Malayan, Tongkah Harbour, Siamese, and Renong give returns between 60 and 90 tons per month.

The Malayan alluvial tin companies have received a slight rebate in connection with the British excess profits tax. Their statutory percentage has been raised from 6% to 13% ; that is to say, they are allowed to distribute a dividend of 13% for any one year before the further profits come under the excess tax. The chances downward of gravel mines are nil, so their lives are limited in comparison with lode mines and the revenue authorities appreciate the difference. But gold gravel mines ought to receive the same favour.

Canada.—Our Toronto correspondent gives details of the Tash-Orn company which has acquired the most promising claims in the Kowkash district, particulars of which were given in an article in our June issue.

That the British American Nickel Corporation means serious business is proved by the fact that it has secured the services of Mr. E. P. Mathewson as general manager, in addition to having Mr. W. A. Carlyle as consulting engineer. Mr. Mathewson has for so many years been identified with smelting at Anaconda that many people have forgotten that he is a big-hearted Canadian. The Corporation owns the Murray mine at Sudbury. Its position was shown in an excellent map of the Sudbury district which we published in our June issue. The Corporation was formed originally by the late F. S. Pearson, who went down with the Lusitania.

United States.—The Consolidated Gold Fields of South Africa has distributed a circular issued by the American Trona Corporation, of which it holds the control. The corporation was formed to work the deposits of mixed salts containing potassium chloride, borax, etc., at Searle's Lake, San Bernardino County, California. The circular states that the plant for producing crude salt mixture on the spot has been completed and is in operation. The refinery at San Pedro, near Los Angeles, is expected to be ready before March next. The present output of crude salt is about 50 tons per day, and eventually this will be increased to 200 tons. The refining process provides for the extraction of potassium chloride and borax, which form respectively one half and one quarter of the crude salt. The method of separation has given a good deal of trouble to the research chemists. Readers interested in the subject will find useful information in papers by Mr. W. B. Hicks, published as professional papers 95 E and 98 A of the United States Geological Survey. The American Trona Corporation has been greatly troubled with lawsuits regarding the rights to possession ; several of these have been successfully fought, but others have still to be settled.

At the Tomboy company's mines at Telluride, Colorado, the results of operations for the year ended June 30 were almost identical with those of the year before, but the dividend was only 10% as compared with 15%. This smaller distribution is explained by the fact that a year ago part of the dividend was paid out of accumulated profit. The ore reserve at the Montana group of mines has been increased from 350,000 tons to 400,000 tons, sufficient to last over $2\frac{1}{2}$ years. At the Argentine group, where the gold ore is nearly exhausted, the lower levels have been found to contain complex sulphide ores of lead, zinc, and copper, which though of low grade should prove to be a useful asset.

No suitable new property for the Stratton's Independence company having been secured in America, the directors proposed to participate in Russian mining operations in the Altai. The shareholders disapproved of this proposal, so it had to be withdrawn, but on the shareholders recommending that the company should be wound up and the cash assets distributed, the necessary three-fourths majority was not obtained. The result is that the company continues in existence, and the directors will no doubt negotiate for new properties.

Mexico.—On September 16, President Carranza decreed that all mining properties failing to resume operations by November 14 would be declared forfeit, and that suspension of operations for an aggregate period of three months in one year would involve the same penalty. The directors of the El Oro Mining & Railway Co. accordingly instructed the manager, Mr. A. F. Main, to resume mining and milling. On October 20 news came that 70 of the 100 stamps had been started. It will be remembered that two other companies operating in the same district, the Esperanza and Las Dos Estrellas, resumed work six months ago. The Mexico Mines of El Oro started work early in September, before the Carranza decree was promulgated.

The Exploration Company is again badly hit by the depreciation of its assets and the consent of the court is to be asked for the reduction of the par value of the shares from £1 to 10s., and the nominal capital from £750,000 to £375,000. On September 30 the depreciation was estimated at £163,820 on account of Mexican investments, £82,374 in South African investments, £39,364 in investments in the United States, and £25,496 in various industrial enterprises, making a total deficiency of £311,054. The Mexican misrule is accountable for the present unfortunate position of things, for the company has large holdings in its subsidiaries, the El Oro, Santa Rosa, and Buena Tierra companies.

Russia.— Difficulties in connection with labour, transport, and supplies have greatly hampered operations at both the Spassky and Atbasar copper mines. Owing to the exhaustion of the high-grade ore at the Spassky, it had become necessary to build concentration plant and a reverberatory furnace to treat the ore of lower grade. It was hoped to have these erected in readiness when the smelting plant that treated the richer ore was closed down early in December of last year, but progress was greatly impeded, and it is only now that the new plant is approaching completion. The reserve of ore awaiting treatment is estimated at 429,475 tons averaging 7·8% copper. At Atbasar no furthur development has been done, and the reserve remains at 543,900 tons averaging 10·7% copper, of which 154,818 tons averaging 13·1% is ready for stoping. The smelting plant is now on its way to the mine, but transport over the steppes is tedious and difficult. The accounts of the company owning these two properties, the Spassky Copper Mine Limited, for the year 1915 are made up at the normal rate of exchange, and show a net profit of £121,515. Owing to the depreciation of the rouble and to the objection of the Russian authorities to the transfer of funds abroad this balance is carried forward. At the same time, the capital required for the new plants at both mines cannot be raised by an issue of shares, so the profits are being employed for this purpose.

The Kyshtim Corporation suffers from the same disabilities as the Spassky as regards payment of dividends for 1915, in this country, and the dividend is made payable at Petrograd, the amount being equal to £83,616, reckoning 15 roubles to the pound. At one time the funds for English dividends was provided by the gold bullion sent to London for refining. Export of bullion from Russia is now prohibited, and the company is erecting a refinery and parting plant at the smelter. The output of blister copper during 1915 was 8138 tons, and at the refinery 7642 tons of copper was produced. The amount of ore sent to the smelter was 364,110 tons averaging 2·86 copper, 1·8 dwt. gold, and 1·1 oz. silver. The ore reserves are estimated at 2,535,000 tons.

Chile.—In our section devoted to the reports of mining companies, we give an outline of the Central Chili Copper Co., which operates the old Panulcillo mine. In past days this mine belonged to a company controlled by the late Sir John Pender, the head of the Eastern and other cable companies. Under the direction of the present board, little distributable profit has been earned, and indeed during some years losses were made. The directors now foreshadow a resumption of the payment of dividends, but at the same time they hint at the impossibility of raising additional capital to develop the property further. These two statements appear to answer each other. The board took the unusual course of refusing to answer questions at the meeting of shareholders, and abruptly declared the proceedings at an end.

LABOUR PROBLEMS IN AFRICAN MINES—III.

By H. FOSTER BAIN.

The author discusses the quality of white labour on the Rand, the high remuneration paid, and the incidence of miner's phthisis. He gives details of the local sources of white labour, and the opportunities for mining education on the Rand.

PROBLEMS connected with white labour at South African mines are hardly less vexatious than are those incident to the employment of the natives. From the Cape to Katanga it is, industrially, a new country; one in which pioneer conditions prevail and skilled workers are scarce. They must either be induced to come to the country, or white men already there, whose previous experience has been in other lines, must be trained to take up new work. Importing skilled workmen is always expensive and usually unsatisfactory. It is generally the man who has not yet acquired much skill or experience, or the one who has made something of a mess of life, who is willing to emigrate. Fortunately it is true, by way of compensation, that in a new country and under new conditions many a man who failed or was only moderately successful at home responds to the stimulus and becomes a success. Nevertheless importing men is an unsatisfactory business. The manager at one isolated African property estimates that only one out of ten white men brought to the property fit into local conditions well enough to become even a fairly permanent addition to the force, and he is a good manager of an excellent property where living conditions are by no means bad and working conditions are exceptionally good. Isolation and the longing for home overcome the good men, and the poor ones are shipped out as rapidly as circumstances permit. Unmarried men do well in such places and save money if they lead clean lives, but married men must face not only the matter of expense but the problem of bringing up children in a country where the white man is in a hopeless minority and where social conditions must always differ widely from those at home. All of these human factors enter deeply into the problem of mining in Africa, and most of them increase the cost. It will be convenient to consider these matters with special reference to the Transvaal, as the gold mines there make the largest demand for white labour and the data are more complete.

In 1915 the average numbers of white and coloured workers employed on the Rand were:

	White.	Coloured.
Above ground	10,016	36,401
Below ground	11,160	146,728
Total	21,176	183,129

The total wages paid to each has already been mentioned. Going back to pre-war times the details as to number of men employed and wages paid for various classes of work by one group may be given for December 1913 as below. There has been some adjustment of wages since, and the numbers employed have changed slightly, but the figures represent usual conditions fairly well.

	Average Number of Men	Average pay per shift s.	d.
UNDERGROUND.			
Miners:			
Machine stoping:			
Contract	1110	28	11
Day's pay	284	20	0
Hand Stoping:			
Contract	398	27	8
Day's pay	918	19	3
Machine Developing:			
Contract	647	36	3
Reclaiming, etc.	398	18	8
Sand filling, etc.	428	13	4
Timbermen	1086	19	10
Trammers, supervising	992	14	7
SURFACE.			
Carpenters	461	20	0
Winding-engine drivers	607	21	8
Fitters	826	20	1

The average wage of white workers, excluding the technical staff, is over £300 per year. It is true that the cost of living is higher on the Rand than in Great Britain or in most other gold-mining districts, but the careful figures collected by the Chamber of Mines show that both absolutely and relatively the workmen on the Rand are better off in a monetary way than those in either Australia or America, and much better off than those in Europe. This conclusion has been endorsed both by the Economic Commission and by the Dominions Royal Commission, and may be accepted as beyond question. Despite these facts it is difficult to get competent miners, and when I visited the Rand I repeatedly found good development faces at which work was stopped, despite the abundance of native labour, because of the absence of white miners capable of effectively directing the work.

Before the Boer War the Rand was a favourite district with good miners. The high wages, the good living, and the excitement of being in a new and active district attracted them from all over the world. The war stopped mining and broke up the existing organization. When it ended, it was discovered that a disconcerting number of the Rand miners who had gone home were dead, and it has never proved possible to revive the current of miners to the Rand, particularly from Cornwall. It was this which first attracted serious attention to the phthisis danger. Until then neither men nor company officials had realized the facts, and for a regrettable period after there was an unwise disposition to ignore them or gloss them over. It is going too far to say that men were "hired by high wages and favourable contracts to commit suicide," but they were not effectively warned, nor were adequate preventive measures taken to protect them. Eventually the companies and the government realized the danger, and prompt steps were taken, not only to compensate injured workers but to remove or abate the conditions that caused it. If any charge of dereliction can now be fairly made it must be against the men themselves who, by carelessness underground and dissipation at the surface, invite the danger.

So much has been printed regarding phthisis in the Magazine and elsewhere, that I shall not attempt here to go into detail. The problem is now becoming better understood year by year. Sure methods of diagnosis have been found, and it is certain that much that was formerly imputed to the disease was really due to ordinary tuberculosis alone or in connection with silicosis. Mining conditions have been changed and, speaking in a general way, the medical problem now does not differ essentially from that of the general control of disease. If the men will exercise care and not weaken their systems by dissipation, the incidence of the disease will be slight. It can now be recognized in its early stages and can be cured, so that the danger to miners on the Rand is probably much less than in many other districts where the very name of the disease is hardly known. This triumph over phthisis is a wonderful boon for which the mining profession is heavily in debt to the medical men of the Rand, and what the latter have accomplished has not received anything like the recognition away from the Rand that it deserves.

Neither is it appreciated elsewhere to what extent the mining engineers and mine managers have altered the conditions underground in fighting silicosis. The essential condition of safety is the decrease in the amount of dust in the air that the men breathe, since it is the fine silicious splinters getting into the lungs that make the trouble. Following careful and painstaking study of the origin and distribution of the dust, remedial steps have been taken along these general lines: (*a*) dampening down the dust as formed; (*b*) removing the men from dusty portions of the mine and at periods when, as after blasting, the air is especially dusty; (*c*) improving the ventilation so as to sweep out the dusty air and substitute that which is clean.

Stringent regulations have been made against drilling or blasting without the use of a water spray, and many miles of water pipes have been carried through the mines. Every effort is made to enforce these regulations and to teach the men by graphic charts and otherwise the advantages of obeying them. From one such chart, issued by the Miners' Phthisis Prevention Committee, it is learned that five minutes after blasting the "cut," when no water jet has been used, the number of dust particles breathed per minute may be 2450 millions; after using the water jet 30 minutes this is reduced to 10 millions. In drilling with $3\frac{1}{4}$ in. piston-drills, collaring a hole dry exposes the worker to 125 million dust particles per minute; with the water in use this becomes 57 million. Drilling dry and wet the figures become respectively 330 millions and 12 or 28, depending upon whether jet or cup be used. With hammer drills without water feed, the number while collaring dry is 64 millions and wet 8. Drilling dry, the figure is 18 million, and with jet in the hole, 9. With hammer drills with efficient water feed, the number while collaring is 3 million, and while drilling, 6. Since the main causes of dust making are drilling and blasting, it will be seen what a reduction the use of water makes possible. Sampling of the mine air is regularly conducted both by the mines and by independent inspectors of the Chamber of Mines. The results of four dust-sampling surveys of the mines in 1915 are quoted by Mr. W. H. Dawe, as chairman of the Chamber, as showing the following averages in milligrammes of dust per cubic metre: (1) 2·7; (2) 4·3; (3) 5·0; (4) 4·9. Of 941 samples taken in all the mines in the course of the fourth dust survey, exclusive of those in the upcasts, 783 showed a content below 5 mg. per cubic metre, which is the standard set. At the time of my visit, May 1916, the results were reported to be still better.

The second preventive step was the removal of the men from the dusty portions of the mine and at times when dust was inevitable. Formerly it was customary in a development heading to blast the cut, then return and charge and blast the round. This is now forbidden, and the regular practice is to work in opposite headings, blasting the cut and round on alternate shifts. How much this retards development and how seriously it affects costs even at best will be recognized by engineers familiar with mining practice in other districts. I doubt if it is generally appreciated that the rule on Rand mines is to work but one full shift in 24 hours. This is not universal, and in development a shovelling shift will alternate with a drilling shift, the round and cut as noted being drilled and blasted separately. Two short shifts in 24 hours leave a long time when the mine is idle, and there are many places where the work stands for 16 hours from working shift to working shift. It is found that the dust-laden air entering a drift after blasting in a stope exposes workers to breathing 1770 million particles per minute. After the mine stands idle over Sunday this is reduced to 4 million, which may be compared with the 2 million less than visible particles found in street air on a dusty day. In order to secure good working conditions therefore the mine stands idle through long hours when interest continues to run against the heavy investment in plant and workings. Under Rand conditions it is not permitted to drive work, as is done elsewhere, with three shifts of men.

The third measure of precaution is artificial ventilation cf the mines, and the amount of attention devoted to this is steadily increasing. It is along this line that there is hope for most progress in the future, and there are reasons, which I shall discuss in another article, why it may prove economical as well as desirable to extend artificial ventilation greatly. It should be noted, however, at what pains and expense both of direct outlay and sacrificed profits, the Rand mines have been made reasonably safe for reasonable workers, so far as silicosis is concerned.

Turning from the problem of inducing trained miners to come to the Rand to that of securing a local supply of white workers brings us at once face to face with the problem of "poor whites." With any considerable number of white men already in the country who must either be taught to support themselves, fed at public expense, or allowed to starve, it is certainly in sound public morals to make strong efforts to bring them into industry rather than to import trained workers, and in South Africa there is such a latent supply of labour.

According to the Union census of 1912 the the white population consisted of 592,782 persons, and the native and coloured, 2,648,658. In the other countries of South Africa the disproportion is even greater. It is currently estimated that south of the Zambesi there are 9,000,000 native and coloured persons, among whom live a small minority of whites. That the balance is not likely to change through normal growth of population is indicated by the fact that even in the Union the number of native women is to white women about as five to one. If the white men are to maintain their position as directors and supervisors only of the unskilled labour of the natives, it is essential that each should himself become highly skilled in some line. Unfortunately, even in the most favoured countries not all white men are fitted either by training or character for skilled work, to say nothing of assuming positions of responsibility for the work of others. This is true in South Africa as elsewhere and, growing out of historical reasons, it is particularly true with reference to skilled work in mining and kindred industries.

There are, as is known, two white races in South Africa, the Boers who are mainly of Dutch descent, and those who are of British stock. The former are decidedly in the majority, and were furthermore the first occupants of the areas in which the mines are situated. The older generation of Boers were pioneers; hunters and cattle men raising a little grain but having, by reason of circumscribed markets, little interest in general trade. Each burger who moved into the Transvaal was entitled to one high veldt farm and one on the low veldt. Land was at first abundant and the holdings large, each of the two farms averaging about 7700 acres. As newcomers entered the territory additional farms were taken up, until all the desirable land had been allotted. While the Transvaal still has large public land holdings, in 1908 equalling 33,746 out of 111,199 square miles, the vacant land is in the low or fever country. Since the Boer had come to value large land holdings from a sentimental point of view and without strict regard to its commercial value, the later immigrants found themselves without a chance of getting an independent foothold. However, while the landowners were unwilling to divide, they had no objection to their land being used by others, so that the newcomers commonly settled down upon the farm of some relative and become "bywoners." In time a large class developed which lived as tenants at will on land which they did not own. The terms were generally indefinite, and seem to have varied from virtual independence to a condition of white serfdom. Both landowner and bywoner depended upon the natives for labour and neither, except in rare instances, became a careful cultivator. Under the system that developed, large acreage is necessary to support the herds which are, even now, the main wealth of the Transvaal farmers.

When the mines opened many of the bywoners found an outlet in the field of "transport riding" which is the hauling of freight, mainly by oxen, with natives to do the actual work while the white man makes the bargains and collects the money. Large numbers were drawn from the farms for this work, but when the railway came their livelihood disappeared at once. In the meantime another factor entered. The growth of industrial centres made a local market for cattle and produce, and therefore land became valuable to its owner, who accordingly was less disposed than ever to see it pass from him or be occupied by another white man. It is possible to hold the land since it is virtually untaxed. Boer families are large and it is customary to inherit by undivided interests. This leads to the brightest of each generation gradually dispossessing their fellow inheritors, who swell the tide of untrained whites flowing from the country to town. So many have in this way been drawn or driven to the towns that indigency is one of the serious problems faced in the Transvaal. It must be remembered that the poor whites, while physically large, have for generations been poorly fed, and have learned to depend upon the blacks for all real labour. They are furthermore hopelessly illiterate. This is not only so but they have acquired a mental attitude, common among all classes in South Africa, that is a tremendous bar to "learning to do by doing" which is the soundest rule of pedagogy. It was characteristic that the white children in an orphan asylum at first refused to make their own beds, considering it to be "kaffir work," but it is discouraging, despite the disproportion in numbers, to be told that in the Cape Province there are more natives than white children in school and that while the natives are eager to learn, white men at times demand that they be paid to allow their children to go to school. It is from such an unpromising source that any considerable local supply of white labour must be recruited.

White men going into the mines may take one of two courses. Either they may elect to become miners and so work up to profitable contracts, or, if young, they may enter the schools with a view to training at the South African School of Mines and joining the staff. It is a curious and unfortunate situation that, except for the few higher-paid positions, the opportunity for making money is better as a miner than as an engineer. The first steps, however, are sufficiently discouraging. While there is no uniform system, all of the mines follow some set routine with new men. The plan adopted at the Brakpan will serve as an illustration. The learner is set to work at 5s. per day, half of which amount is paid by the company and half by the contractor to whom he is allotted. The man takes the place of a native on a drill and works side by side with black men. Apparently because it is regarded as distinctly temporary, he seldom objects to this. After six months probation at this or similar work he is given, if he shows promise, a temporary blasting certificate which permits him to handle explosives. This is good for six months. At the end of that period, if he has continued to improve, he may come up for public examination before the mine inspector and receive a permanent blasting certificate, after which he is regarded as a fully qualified miner and is entitled to full pay. It will be seen that the system, slight as it is, makes a heavy demand upon a newcomer from the country who probably has a large and growing family. The Boers are, however, responding to it, and the proportion of native born in the mines is increasing. Once possessed of a certificate many of them do fairly well, their experience in directing black labour compensating in part for their ignorance of mining. While there is much complaint as to easy granting of blasting certificates and lack of real skill, the system should be contrasted not with ideal conditions but with that in other countries where white men go to work in mines at whatever post they can find, with no training, and usually at full pay. Only by trying and losing several jobs do they there acquire such training as ultimately becomes their stock-in-trade.

An effort has been made on the Rand to give better training to those who will take it and so to afford a basis for recruiting men for the more technical positions. In addition to a particularly complete system of night schools, opened at various points along the reef under the auspices of the South African School of Mines, a special school for miners is supported from public funds at the Wolhuter mine. The attempt has been made to keep the boys in school for three full years, but it was found that in the face of immediate opportunities for earning money and even at the risk of landing in a "blind alley," 36% of those who entered left at the end of the three months probationary period. The course has therefore been shortened to two years and the probationary period abandoned. The course involves both schoolroom and practice, the mine being substituted for the shop and foundry in the usual trade school. The cost per pupil and the numbers attending for three years was as below:

	£	s.	d.	Number
1913	24	0	8	50
1914	31	8	5	46
1915	52	11	11	39

It remains to be stated that all the boys taking the course have promptly found good positions, but the small number availing themselves of the opportunity is discouraging.

The members of the staffs of the mining companies are recruited from many lands and from many schools. An increasing number of native born are finding their way to the top, and the facilities for technical instruction in South Africa are now excellent. Before the South African war there was an arrangement whereby engineers were trained with a year each at the South African College at Capetown, the Kimberley School of Mines, and on the Rand where they worked in the mines under guidance of a resident professor. It was an unusual and interesting system, and some of the best men on the Rand came up under it, but with the growth of gold mining it was felt that Johannesburg should have an institution for the full training of technical men for its chief industry. Accordingly in 1902 a committee was appointed by the Director of Education to consider the matter. It is interesting to run over the names of the members of that committee. They were Mr. Fabian Ware, later himself Director of Education, who was chairman, and Messrs. H. C. Behr, A. F. Crosse, H. S. Caldecott, Max Francke, F. H. Hatch, Hennen Jennings, Sidney Jennings, W. A. Caldecott, J. H. Johns, E. B. J. Knox, E. J. Laschinger, E. N. V. Melville, Theo. Reunert, A. M. Robeson, H. Spengee, W. K. Tucker, J. R. Williams, H. H. Webb, and A. Wilkinson, with John Robinson as secretary. With such a committee trustworthy and significant results were assured. Out of its work has grown by various stages the present South African School of Mines and Technology. The school occupies a prominent site in Johannesburg, has an excellent building and serviceable shops, a good library (the Seymour Memorial), well equipped laboratories, and a faculty of strong, able instructors. I should like to discuss its work in some detail, but can only take space here to dwell upon one point, and that is the closeness of the co-operation between the school and the mines. It has never been my pleasure to visit a mining school where it seemed to me there was quite the same contact as here. This is not especially surprising, since schools are seldom situated within actual sight of such mines as on the Rand. The students come into daily contact with actual mining, they live in a mining atmosphere, and they meet mining men. The Chemical, Metallurgical, and Mining Society holds its meetings at the school, and has its headquarters on the premises, as does also the South African Red Cross Society, which is taking an active lead in organizing first-aid work in the mines. The students therefore absorb practice while they study theory. There is also a regular system of instruction in the mines and of putting the graduates to work when they leave school. Any young man who does reasonably well in his school work is sure of a position, and even those who do less well get a chance. That period of doubt and uncertainty which faces the graduate of a school at home or in America does not exist for the budding engineer at Johannesburg. His older professional brethren have quit talking about "how to start the college graduate" and are busy starting him, with every opportunity for advancement. The system of night schools already mentioned gives the graduate as well as workmen every opportunity to broaden out as much as he will.

In only one particular does the co-operation between the mines and the school seem less close than it might be, and that is in regard to experimental and research work. The excellent results achieved by the Mines Trials Committee are widely known, but the difficulties under which it has operated are not so well understood. Having no independent laboratory, it has had to use existing plant when and as it became available. In one instance it took two years to conduct a series of tests, although not more than three months was actually devoted to the test. The remainder of the time was lost in waiting for the necessary apparatus to be available under proper conditions. Assuming a favourable result from such a test, it will be seen that the loss due to delay in applying the result might well be serious. I have little doubt that such losses have long since amounted to more than the cost of centralizing the work. The School of Mines has in its present laboratories and faculty an excellent nucleus for building up a proper Engineering Experiment station. For large scale work, and because on the Rand insistence upon this runs if anything to extremes, it should be easy to provide suitable additional plant. Any of several mines could and doubtless would give a site and possibly a building. Among the mills already closed or to be closed something may already be available. Many of the manufacturers would supply machinery free or at low cost, and money for support might fairly be asked from both the groups and the government. There is an enormous amount of research under way on the Rand at all times, but centralizing and co-ordinating it would multiply its value and shorten the time necessary to reach definite results.

When a young engineer joins the staff of a Rand company his normal route of progress is from sampler to surveying office, then to shift boss, mine captain, underground manager, and so to mine manager. The latter position is by law reserved to those who have had underground position and since, except the few positions on the Rand open as consulting engineer or consulting metallurgist, it is the one best paid, the more ambitious beginners begin underground instead of on the surface as is common elsewhere.

Until one reaches the position of underground manager he may be in the anomalous position of directing men who draw more pay than he does. Generally speaking a shift boss receives £40 to £60 per month and a mine captain £60 to 90. The miners work by contract. The ruling flat wage is £1 per day and the actual cheques to contractors on one large property now run from £60 to £160 per month. An effort is being made to establish £60 as the proper wage, but it is far from being the ruling scale now. With such wages it is not surprising that miners coming from abroad to serve as shift bosses throw up their jobs and take contracts, but is it surprising to find on the Rand dissatisfaction and unrest among labouring men as in other districts where there is more justification. It will be remembered that there has been one strike accompanied by riots, and that another was only nipped in the bud by the prompt and effective action of the government in calling in the commandos from the surrounding country. It is difficult to see what just basis there is for labour troubles so far as pay is concerned. Indeed, taking account of money spent on the races, on liquor, and on women, a grave question arises whether wages are not too high now for either individual or community good. That a company pays a contractor such amounts as have been mentioned means merely that the average efficiency is so low that a good man can make a most exceptional return. It leads to dissatisfaction on the part of the others who, as is well known, wander up and down the land looking for a "snap" and never working long at any place. These men become dangerous to the mines both in their poor work technically and as dissatisfied wandering agitators. These facts are realized at Johannesburg and efforts are being made to rectify the situation, but it will require more than cutting wages. Conditions underground must be still further improved, and a long persistent campaign of education must be conducted. Incidentally, experience elsewhere indicates that better machinery for considering grievances, real or supposed, would be helpful. While something is done in this line the Rand is still far behind other big mining districts in looking beyond the day's pay to the social effect of mining conditions. Under the leadership of Mr. C. D. Leslie, of the Gold Fields, a system of annual vacations has been adopted, and most of the companies support clubs or recreation houses, but there is still much to be accomplished along these lines. Probably also the colour bar will have to be lowered if not abandoned, and qualified black men given opportunities in some at least of the skilled work of mining. This is adjudged locally to be politically impossible at present but, whatever the politics of the matter may be, the present labour situation as regards both black and white workmen is unstable and full of dynamite. If a change is to be made, it is certainly better statesmanship to bring it about in an orderly and planned manner than to give grudgingly something that is forced.

The Guggenheim firm has changed its title from M. Guggenheim's Sons to Guggenheim Brothers. Meyer Guggenheim, the founder of this American firm of mining financiers, landed as a poor immigrant in Philadelphia in the year 1847, and he died in 1905. He prospered as a dealer in lace. Subsequently a money-lending transaction resulted in his obtaining control of the A.Y. and Minnie mine at Leadville. Later he joined with others in building the Philadelphia smelter at Pueblo. He had seven sons, Isaac, Benjamin, Daniel, Murry, Solomon, Simon, and William. Benjamin was lost in the *Titanic*, and William is at enmity with his brothers. Harry, the son of Daniel, and Edmund, the son of Murry, are following the mining business.

AN ENGINEER'S TRAVELS IN WESTERN CHINA.

By J. A. T. ROBERTSON.

The author is a Canadian engineer holding the professorship of mining and metallurgy at the Technical College at Cheng-tu. In this article he gives notes of a journey of observation through the mineral districts of Sze-chuan. His information supplements that contained in Mr. Way's paper, which appeared in our July issue. The western states of China will, in the near future, afford opportunities for British mining activities.

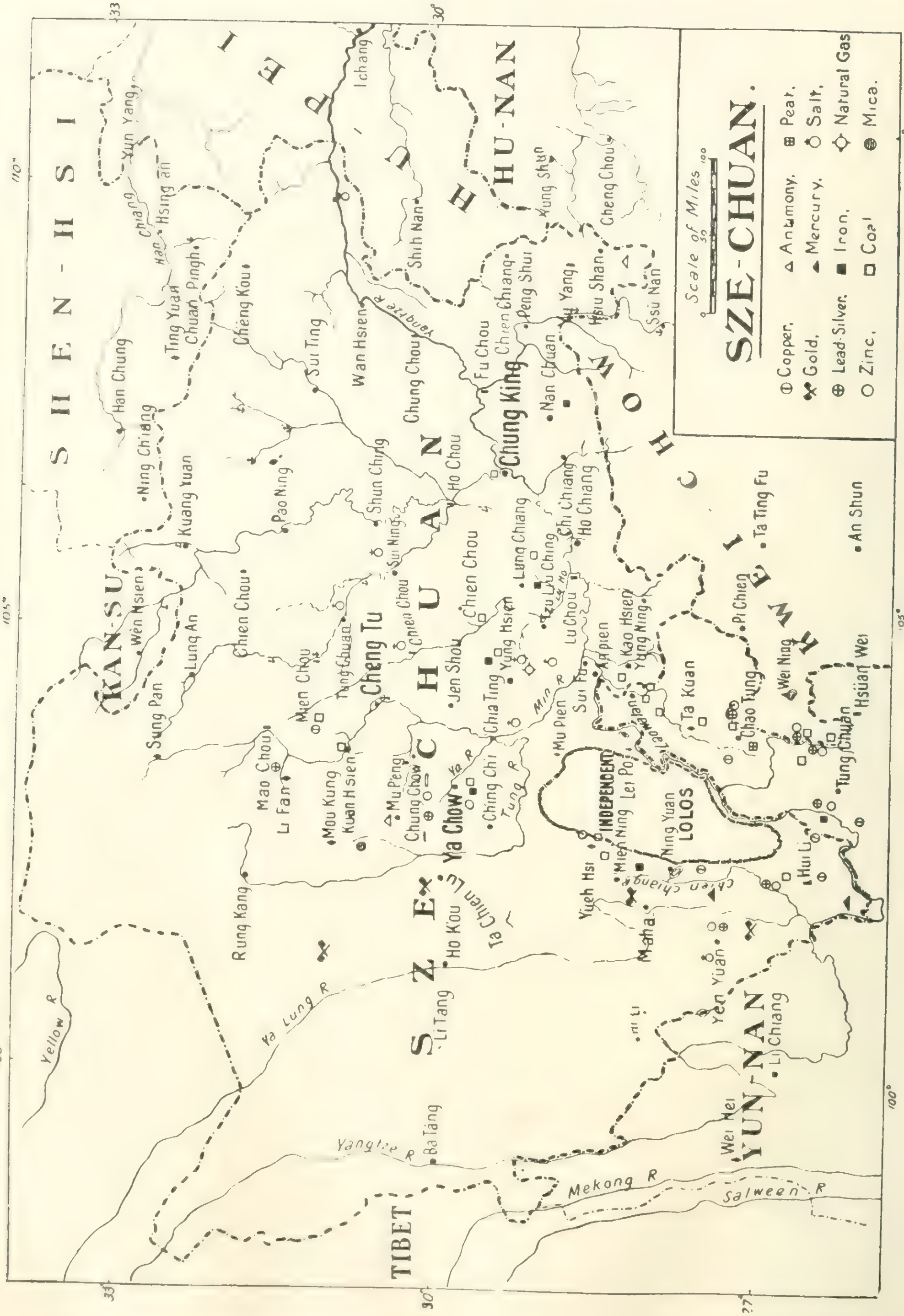
THE three western provinces of China, from north to south, are Kansu, Sze-chuan, and Yunnan. Sze-chuan is the largest of the eighteen provinces, having an area of over 200,000 square miles, and a population usually given as 67,000,000. But this latter figure is only an estimate and, I believe, too great by possibly 15 to 20%. It is also one of the richest provinces of China, and under the Ta Ching Dynasty had to send annually large quantities of silver to its poorer neighbour, Yunnan.

The province has large natural resources, and some, for example its mineral deposits, have hardly been touched as yet. There are plenty of mineral occurrences known, and the traveller finds many workings of a primitive nature. The methods employed are often close parallels to those described by Agricola in the 16th century. But in spite of these numerous small workings little has been done as yet. There are many reasons for this backwardness, among which are: (1) Inaccessibility; although transportation is not any worse than in many districts which are successfully developed in other parts of the world. (2) Primitive methods of mining and metallurgy; for example no explosive stronger than gunpowder is used in any of the mines, and it is only quite recently that any explosive was used at all. Again they have no method of handling water other than the Chinese pump, a wooden chain scraper in a snugly fitting wooden trough, good for lifts of 8 to 10 feet; and a lift pump made of bamboo pipe, good for lifts of up to 24 feet. (3) Inadequate mining laws, and more particularly maladministration on the part of the smaller officials. (4) The fact that much of the mineralized part of the province lies in the mountains along the Tibetan border, which is inhabited by more or less independent tribes who are not friendly to the Chinese. And (5) lack of mutual confidence among the Chinese themselves; this makes it impossible to organize anything but a one-man company, which has not the available capital necessary to overcome the difficulties that always beset the small operator. Therefore the only important attempts to develop certain deposits have been undertaken by the Government.

Cheng-tu, the capital of the province, is one of the cleanest and best governed cities in China. The wall is about 40 to 50 ft. high and about 40 ft. wide on top, and is probably better preserved than that of any other city except Peking. The population, including the residents in the suburbs outside the four old gates is probably close on half a million. It is the political and educational centre of the province; but from a business point of view is far behind Chung-king, the chief port on the Upper Yangtze.

Having heard much about the southern part of the province I decided to visit it in the summer of 1915. Therefore the morning of June 28 found us aboard our little boat at the Ta-ma-tou just outside of the East Gate. This was the season of high water and the river was crowded with small boats of every description, and being the close of the school term many of the boats were occupied by students returning home for the summer vacation. Everybody travels by boat in China wherever possible, as it is much more comfortable, and also cheaper for a Chinaman, than travel by sedan chair. They can rent enough room to spread their bedding on a cargo boat for 200 or 300 cash per day, rice included; or else twenty or more engage a whole boat that would hardly accommodate two foreigners. Much of Sze-chuan is particularly adapted to this mode of travel, as the whole of the eastern part of the province is a network of streams, navigable for small boats drawing from less than 1 ft. to about 3 ft. And as all of these streams ultimately join the Yangtze, the great highway of central China, it is possible to get in freight although there is no rail connection to any part of the province.

As there is a good current in high water and as we had two or three rowers, standing


SZE-CHUAN.
Scale of Miles
⊕ Copper. △ Antimony. ⊞ Peat.
Gold. Mercury. Salt.
⊕ Lead-Silver. ■ Iron. Natural Gas
○ Zinc. □ Coal ⊕ Mica.
SHEN-HSI
HU-PEI
HU-NAN
KWEI-CHOW
KAN-SU
SZE-CHUAN
YUN-NAN
TIBET
INDEPENDENT LOLOS
Chung King
Cheng Tu
Ya Chow
Ichang
Wan Hsien
Chung Chou
Fu Chou
Sui Ting
Han Chung
Ning Chiang
Kuang Yuan
Pao Ning
Shun Ching
Ho Chou
Chien Chou
Lung An
Sung Pan
Wen Hsien
Mao Chou
Li Fan
Mien Chou
Jen Shou
Chia Ting
Sui Fu
Lu Chou
Nan Chuan
Kao Hsien
Yung Ning
Ta Kuan
Chao Tung
Tung Chuan
Hui Li
Ning Yuan
Yueh Hsi
Yen Yuan
Li Chiang
Ho K'ou
Li Tang
Ba Tang
Rung Kang
Wei Hsi
Ta Ting Fu
An Shun
Pi Chieh
Wei Ning
Hsüan Wei
Yangtze R
Min R
Ya R
Tung R
Ya Lung R
Mekong R
Salween R
Yellow R
Chien Chiang
33°
30°
27°
100°
105°
110°

and pushing on their oars, we made good time. After leaving the Cheng-tu plain the river winds through low hills of a soft red sandstone, which covers a great part of eastern Sze-chuan and is classed by Richthofen as basin deposits of probably Jurassic to Cretaceous, and some of it probably as late as Tertiary. It has been much dissected by erosion, forming little ridges and disconnected hills, but through this part it has not been disturbed by any of the later movements common to some parts of the province. The sandstone is soft and easily quarried and has given rise to quite an industry along the river. It makes good foundations, but is rather soft for use where exposed to the weather.

The first important city is Chia-ting, which is a crowded dirty little city of 30,000 or 40,000 inhabitants, built on a narrow point at the junction of the Tung and Min rivers. The Ya joins the Tung just above the city, so that its walls are surrounded on three sides by good sized rivers. I might remark here that all the larger walled cities that I have seen in China occupy strategic positions of great importance, and most of them must have been impregnable under former military conditions; and they would be a hard nut to crack even today for anything less than siege howitzers, as was shown by the attempts to break the wall of Nanking during the revolution of 1911.

Twenty or thirty miles southwest of Chia-ting, Omei shan, the famous sacred mountain of Western China, rises to 10,500 ft. It is covered with Buddhist temples, and is visited by thousands of pilgrims annually from all parts of China and Tibet.

At Chia-ting you can see large numbers of the bamboo rafts which come down the Ya. They look like huge toboggans 6 to 10 ft. wide and 50 to 60 ft. long. They are made of bamboo poles, 4 to 6 inches in diameter, lashed together and curved up a couple of feet in front. On this is built a little platform to keep perishable goods out of the water, which washes freely over the raft when loaded. Because of the many airtight compartments in the bamboo they can carry marvellous loads.

There is a huge image of Buddha carved in the red sandstone cliff opposite the lower point of the city. The district behind is interesting on account of the large number of ancient burial caves found in the sandstone cliffs. A number of these have been opened by M. Bons D'Anty, Consul General of France, and the Reverend T. Torrence, of Cheng-tu, and a number of excellent specimens of ancient art have been recovered.

West of Chia-ting, up the valleys of the Ya and Tung, we found many small copper and lead-silver mines, most of which have been abandoned shortly after reaching water level. The remainder were closed for the summer because of the rainy season, when water comes in faster than they can pump it out with their bamboo pumps, and also because like many other small mines throughout the province, they are worked by farmers who were busy attending to their crops.

Just below Chia-ting you pass several salt wells, this being the western limit of the great salt-well district of Sze-chuan which centres around Tze-lui-ching.

Throughout this district we found many small seams of fairly good coal, occurring in sandstones and shales that are probably Upper Carboniferous to Cretaceous. Much of this coal, occurring near the rivers, is loaded on to boats and sent up as far as Cheng-tu, where it competes with coal brought down from Kwan-hsien, about 40 miles west of Cheng-tu.

Near the city of Yung-hsien they are working numerous small lenses of carbonate of iron in limestone. The lenses average 4 to 4·5 ft. thick, 20 to 30 ft. wide, and 100 to 200 ft. long, and all those being worked lie within 25 ft. of the surface. They are said to occur over a large area, and the ore averages about 35% iron. No explosives are used, the ore all being broken by hammer and chisel. The roofs are supported by a combination of timbers and pack-walls, the latter built of stone brought from the surface. Labour is plentiful and wages are 100 to 120 cash per day and rice, which costs probably 60 cash per day. The total wage is equal to about 3d. per day.

The ore is broken to 1 to $1\frac{1}{2}$ inch lumps and calcined with wood in kilns of about 2 tons capacity, the operation occupying 4 days. The calcined ore is smelted with charcoal in small stone furnaces, about 16 ft. high and 8 ft. diameter. The blast is supplied by hand-operated piston blowers, through two tuyeres in the back wall. Practically all the iron is used in casting evaporating pans for the salt wells. No smelting is done during two or three months of the hottest weather.

At Sui-fu the Min joins the Upper Yangtze, or as it is called locally the Golden Sands River, the reddish brown water of which makes the muddy Min look clear by comparison. This stream brings down great loads of sediment annually, and at almost any place above Wan-Hsien during low water you can find men washing the gravel, brought down by the last high water. I have often watched them make

WASHING GOLD GRAVEL ON THE YANGTZE RIVER BELOW CHUNG-KING.

their clean-up, and wondered how they make a living, and what is the economic limit at which they stop washing. At some places I am sure they do not average 60 cash per day, but they work this during the off season on the farms when there is often nothing else to do. Farther up they find coarse gold in places, but as soon as a discovery excites much attention the district is withdrawn by the Gold Mining Bureau, which has recently been formed to furnish the gold to put the Chinese currency on a gold basis. The accompanying photographs illustrate the type of rocker used and the method of operation.

The river at Sui-fu is only 800 ft. above sea level, but the city is surrounded by hills, some of which rise to 2000 or 2500 feet, and on four or five of them can be seen pagodas, a liberal allowance for even an ambitious city. This is the terminus of one of the two routes which have been surveyed for the extension of the French railway from Yunnan-fu to the Yangtze. Although a British gunboat has visited Chia-ting every summer in highest water for some years, Chung-king is still the head of steam navigation on the Yangtze, but there will probably be steam service between Chung-king and Sui-fu in the near future.

I had written to Dr. Tompkins to secure ponies for us, but being unable to get any, he had engaged chairs and load coolies to Chao-tung, so that we were able to leave in the morning. From Sui-fu the road follows up the north bank of the Yangtze for about twenty miles, and then crosses to the south side and follows up a small stream, practically along the line of the proposed railway.

At An-pien, where the road crosses the river, I was told that the coal mines were not more than three miles farther up. So in the morning I called Mr. Wang, my interpreter, and taking a coolie to show us the way, set out to visit them before breakfast. They proved to be nearly ten miles away and we were hungry when we got back about 11.30. The seams are from 1 to 4 ft. thick, and occur in sandstone near the top of the hills on both sides of the river. The coal is swung down to the river on bamboo cable-ways. Where there are ledges of any width below the mines they have to operate the cable-ways in sections, as the sag is so great that the baskets could not clear the ledges.

The track cables are plaited of flats strips of bamboo (much like the towing ropes used by the boatmen) and are about 4 inches in diameter. At the lower terminal, provision is made for taking up the slack by taking a hitch on the track cable with a smaller rope, also of bamboo, which passes around a roller log. This log is turned by capstan bars and blocked when the desired tension is obtained.

The haulage rope is 0·75 in. diameter, also of bamboo, but twisted in three strands. One end of it is attached to a bamboo basket on each of the track cables. At the upper terminal it makes several turns round a vertical drum and the speed is controlled by other bamboo ropes acting as friction brakes on this drum. The particular cableway I examined took about 40 seconds for the trip, not reckoning the time the lander takes in dumping the basket, which may be ten minutes if he happens to be smoking when it comes down. This pair of ropes is said to cost 40,000 cash (£2. 14s. 5d.) and lasts one year. The coal is loaded on to boats and dropped down to An-pien, where it sells for one cash per catty (1·33 lb.) or about 2s. 3½d. per ton. Farther up the river are a number of lead-silver mines, but I did not have time to visit them.

Some of the small streams along the road are crossed by what was a new form of bridge to me, and appears to be a connecting link in the evolution of the bridge from the stepping-stones. A row of stone piles are set into the bed of the stream, and stand as much as 10 to 15 feet above ground. They are spaced close enough that each just makes a step, and they are notched on the edges to receive a short plank which completes the bridge. But as this was the rainy season, and any of these inoffensive looking little streams might become a raging torrent at a moment's notice, the planks had been removed to prevent their being washed away and the bridge consisted only of stepping-stones.

The larger streams are crossed by suspension bridges of iron chains, the links of which are usually bars varying in length from a couple of feet to nearly 100 feet in a few cases, and about 3 inches in diameter. Usually the floor boards are supported on eight or ten of these chains and two or four more form the side rails. But at Lao-wa-tan there is a really fine specimen, built much like our suspension bridges, with seven chains on each side, from which a well arched and well braced floor is suspended by smaller vertical chains.

Shortly after crossing the Yunnan border, we arrived at Lao-wa-tan, a dirty but busy little town at the head of navigation on the stream we had been following. The pack trains bringing down tea, lead, and copper all stop here, and what is not taken down by boat is carried by coolies. They say that the coolie union will not allow the animals to come down any farther. Like most Chinese market towns, it consists of one long street; the buildings on one side backed up against the hill while those on the other overlooked the river. We were late arriving, and I was unfortunate enough to get a room overlooking the river, and some 8 feet off the ground. Below us was the combined lavatory and pig pen from which we were separated only by a plank floor, in which the cracks were half an inch or more wide. After that experience I detailed two of our

Chinese Rocker used in washing Gold Gravel.

numerous escort to hurry ahead each day and secure a room that was built on the ground and as far removed from the ubiquitous pigs as possible.

Coal seems plentiful and can be bought for from one to three cash per catty at any place along the road.

About three miles below Lao-wa-tan they are getting salt from springs by the river side. In fact all but one of them was drowned out by the high water. It was only a little hole in the broken limestone a few feet back from the river and connected with it by cracks in the broken formation, so that the brine was about as muddy as the river itself. The brine was warm, 109° F., while the atmospheric temperature at the time was only 86°, and it was hardly as salt as sea water. They told me that at low water it was much hotter, stronger, and clearer. There was one well that had been drilled a little way from the river, about a foot in diameter and cased with stone blocks like the wells at Tze-lui-ching. How deep it was and whether it had ever produced or not I do not know, as they told me at the river that they had never been able to tap the springs by drilling on the hill. But the owner was very proud of it, and told me that it was choked up now, but that he was going to clean it out. He was an elderly man, and regarded that well just like a child would a new toy. When I held up both my thumbs, indicating that it was first class, he almost hugged me and insisted that I should go in and drink some of his vile rice wine. I escaped, however, by asking him to show me the evaporating process. At this time they were only getting 10 oz. of salt from 100 lb. of brine, but at low water they said that they got a little over one pound. The salt tastes well, but is grey with dirt. It sells for 100 cash ($1\frac{1}{3}$d.) per catty.

At Tou-sha-kuan the river flows through a narrow gorge with practically vertical limestone walls reaching a height of 400 or 500 ft. at the western end, with the strata dipping away toward the east. There are many little caves in the limestone with large stalactites hanging from the roof. In what looked like a shallow cave, but might have been a ledge, in the opposite wall of the gorge and about 150 ft. above the river, were the remains of many rough coffins. On inquiring from some of the natives, I was told that they had been put there by a general, Chu-Ko-Liang I think, long ago in the Han Dynasty, who had been sent to drive back the savage tribes. In this way he hoped to make them believe that he had killed very many of them and thus frighten them away. But when I got down among the Miao tribes, they told me a different story. They said that Chu-Ko-Liang, being unable to defeat them, had made friends with them, and finally persuaded them that if they would remove the remains of their ancestors to this cliff great good fortune would be theirs. After much persuasion they did as the wily Chu advised, only to find that the spirits of their ancestors were displeased and that he was able to conquer them. They also showed me some holes in the limestone which, with considerable stretch of the imagination, might be the impression of a horse's hoof some 8 or 9 inches across. These they said were the marks of his horse. They told me many other stories about this crafty general, of which the following is a fair sample. One time when he was defeated and was being hard pressed, he fled with only two or three of his followers and took refuge in a deserted city. He left everything wide open, and disguising himself as a beggar, took his harp and sat on the wall over the open gate playing. When his pursuers came along they stopped at the open gate, and a few were for going in, but the majority said no ; they were sure it was some trap that Chu had laid for them, and so they made a detour of the city and went on.

From the Yunnan border to a little past Ta-kuan the rocks are principally limestone with smaller amounts of interbedded sandstones grading into shales. At some places the limestone is thick and massive, while at others it is closely interbedded with shales, the individual laminæ being only about an inch thick. The limestone is rich in fossil remains, but as my time was limited, we had to keep pushing along, and I was not able to spend any time collecting. However, I was able to pick up about fifty specimens. These indicate that the rocks are probably Permo-Carboniferous.

About ten miles beyond Ta-kuan our road suddenly seemed to end, for the stream that we had been following rushes out from under a limestone cliff, while the valley ends in a little amphitheatre, the only opening from which appeared to be the notch by which we had entered. But just as I was thinking that I must have passed the road in the little village called the "origin of water" where my men had stopped, it turned suddenly to the south up a rift almost along the contact of the limestone with a basaltic rock. The later was the first igneous rock we had seen on the trip. About half way up I stopped to get my breath and pick some blackberries, when I thought that I must have disturbed a bees' nest; but I found that it was nothing but the murmuring of some stream following its subterranean channel far below. It could not have been the main stream, for it issued from the opposite side of the valley. From the summit we had a grand view through a little break in the hills, where a regular sea of mountains, with white fleecy clouds hanging over them, stretched away to the east of north as far as the eye could see. The road then led out into a flat and in some places marshy alluvial basin. A small muddy stream meandered across this basin until it disappeared into a sink-hole, and pursued a subterranean course to where we saw it issuing in the valley a thousand feet below.

We were now on the Yunnan plateau, where it is a common sight to see a stream disappear into the hills and be lost for a time. From now until we neared Ya-chow our road lay between 6000 and 10,000 feet above sea level, except where it dipped into the valley of a few of the larger rivers. Although the sun was nearly vertical, there was always a pleasant breeze, and the thermometer rarely rose above 75° in the shade, while the nights were always cool. One of the most striking things was the entire absence of bamboo, which does not grow at such high altitudes here. This mav appear a small thing, but it enters into the every day life of the Chinese in so many ways that we almost felt we had come to a different civilization. Most marked were the houses, which are all of mud and mostly not even white-washed, in contrast with the neat "pih-teo" (lath and plaster) construction of Sze-chuan, where split bamboo interlaced takes the place of our lath. Also the greater poverty of the country was apparent at every turn. Instead of the luxuriant growth of rice and beans we had been passing through we found very little and rather poor rice, most of which was the red variety common to these higher altitudes. The main crops appeared to be maize, buckwheat, and potatoes both Irish and sweet. The poverty was also noticeable in the currency. The copper cash are much smaller and change 1800 to 2000 for a dollar instead of 1400 as in Sze-chuan, while the ten, twenty, and fifty cash copper coins common in every town in Sze-chuan were entirely unknown here. While you hardly ever see a silver coin smaller than a dollar in Sze-chuan, here you practically never get anything larger than a fifty-cent piece. When offering a dollar in payment for some small purchase, I was often asked if I had not a ten or twenty-cent piece. In cashing a draft you get about 20% of it in this small silver, which I at first refused to take, as it is impossible to use it in Sze-chuan except in a large city.

Following up this little stream to its source and climbing over a low range of hills we descended on to the Chao-tung plain, as it is called, though it is really a basin about 30 miles by perhaps 20 miles at its widest. The roads across the plain are badly cut up by their ox carts, of which they are very proud. We met many of these jolting home from market loaded with all the women folk and purchases, with the farmer plodding along at the side of the beast and urging him on with a dissertation on his family-tree that did not repeat itself for half a mile. One man who was giving his ox a rest asked me if we had any carts like that in my honourable country, and when I told him that I had seen a few in the province of Quebec, but that nobody used them if they could afford anything better, he was greatly surprised.

Chao-tung, the most important military and political city of northern Yunnan, is a rather small, walled city, and, if we are to believe the interesting inscription on a stone tablet in one of the temples of the city, was founded by the Ibiens less than 200 years ago. This is quite recent when compared with cities like Cheng-tu, which has a continuous history of over 2000 years. West of Chao-tung they have recently opened up several copper mines, but owing to lack of capital they have not done much with them as yet. In Chao-tung I met an old Lolo chief, Mr. Long, who is related by marriage to some of the largest chiefs among the Independent Lolos. He was interested in a silver mine, which he said they had been forced to abandon because of gas, and he was anxious to take me into Lolo-land to look at it. He promised to take me across Lolo-land to Ning-yuen, but said he could not guarantee the safety of Mr. Wang, my interpreter, or any other Chinaman. I asked him how about myself, and he said, "Oh, you are a foreigner, and all you have to do is to tell them how you hate the Chinese and you will be a big man among them."

The Reverend W. H. Hudspeth, of the United Methodist Mission, whom I had met in Cheng-tu two years before, met me in Chao-tung and took me out to Stone Gateway, just across the Kwei-chou border where Mr. Pollard (who afterward unfortunately died of typhoid fever) and he were working among the Miao. I enjoyed a few days stay here, as it gave me a chance to see something of these aborigines. While we had been travelling through their country for several days we had got to know little of them, for they are a shy timid race existing in a state of servitude to the Chinese and Lolos. They are only to be found in small villages scattered among the hills, where they live in little two-roomed mud huts; one room serving as stable for their goats, cattle, pigs, chickens, etc., while the other, furnished with a fire pit in the centre and a few low stools, serves as general living,

COFFIN CLIFF.

dining, and bed-room for the family. Typhoid makes great ravages among them every year, and one home I was in had only a baby under one year and a girl of about ten years left out of fifteen children. Their clothes are principally of hemp and wool, grown, spun, and woven by each family. The women wear a fancy kilt, much like a Highlander's in cut; and the married women after giving birth to a child put up their hair in a poke that is characteristic of the tribe. Like all the different tribes we saw on our trip, and even between different villages of the same tribe, their distinguishing feature is in the women's dress, as the men have almost entirely adopted the Chinese dark blue with a coarse felt cape, which protects them from the wind and rain while watching their flocks on the hills and serves for bedding at night. They have a strong crossbow with which they shoot poisoned arrows with great skill. I secured a crossbow but had to have new arrows made, as it seemed impossible to get any that had not been poisoned. I was also able to buy ponies for the remainder of the trip here, for about thirty dollars each; which was at least 30 to 50% less than I would have had to pay a horse dealer in Chao-tung. And it also gave me an opportunity to test my saddle ponies, as we were in no hurry.

The students got up a little entertainment in our honour, and while they sang in Miao, the teacher beat time on the edge of the platform with a long ruler, making about as much noise as the singers. On Sunday morning I met the mother of one of the boys studying in Cheng-tu. She rubbed my sleeve while she told me how she loved me and how sorry she was that she had not known that I would be there so that she could have brought a present of eggs. At least that is what Hudspeth said she was saying, and he said that if she were not a little afraid of me she would rub her hands all over me from head to foot instead of my sleeve. In the afternoon the owner of an abandoned lead-zinc mine, a few miles below here, which we had looked at, sent word that he would be glad to give me the mine provided that I would give him a good job.

I tried to persuade Hudspeth to come with me and Mr. Long on the trip through Lolo-land, sending Wang around by our original route with the rest of the party. But it was impossible for him to get away then, and not caring to risk it alone on my limited knowledge of Chinese we followed on south along the Kweichou border, visiting several lead-zinc mines.

We were now off the main road, or in fact any road at all, and we put up with some farmer wherever night overtook us. While it was often a little crowded, it was at least much cleaner than at the average inns. Though coal is plentiful, often actually outcropping on the hills, the people all burn brush, pine needles, and dry grass twisted into long ropes; and the pine-covered hills are swept as clean as a park at home. I presume this is because they use no stove, doing all their cooking over an open fire in the middle of the floor. One day we passed a house where they were counterfeiting the small cash. I asked how they could do it at the present price of copper and zinc and they said they used lead instead of zinc.

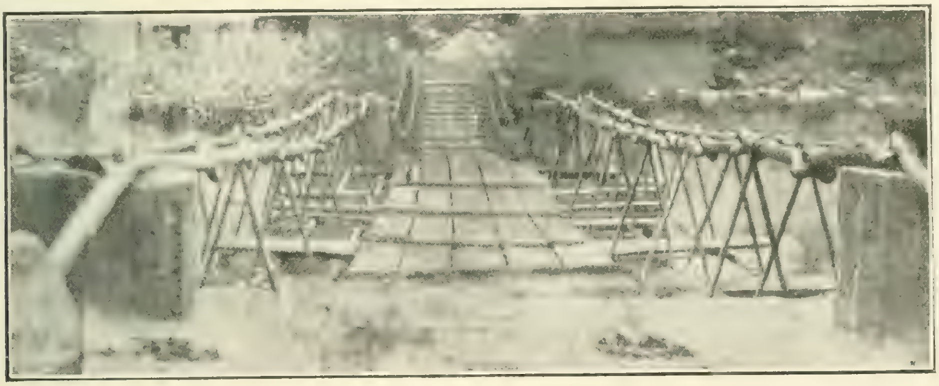
As there had been much rain the streams were often swollen and difficult to ford. Mr. Wang laughed at my advice on handling his pony in fording, and as a result his horse lay down on him one day. Fortunately the water was not very swift and he escaped with a wetting and a broken girth on his saddle.

We found the most important of the silver-lead-zinc mines of this district at Kung-hsien, in much fractured limestone within a few hundred feet of the contact with a basaltic mass. The mines originally belonged to the Miao from whom they were purchased by two Chinese merchants. Now they are under the control of a government mining office, which operates four shafts and buys all the ore and metal from the tributers. There are shafts scattered all over the town, but most of them, 14 or 15, go down from a small open pit on the hill just above the town and close to the igneous contact.

The largest and deepest mine is said to have between 8 and 10 miles of workings; but they assured me that I could not get through many places in it, and advised me to go down a smaller but more recent shaft with larger workings. Even here I had to crawl on my hands and knees for hundreds of feet at a time. But most of the passages are about 4 ft. high by $2\frac{1}{2}$ ft. wide. They are all closely timbered with tunnel sets of scrub pine, about 3 inches diameter, but the sets are only about 9 inches centre to centre. Behind this is close lagging of the same pine, split thinner than shingles and 18 to 24 inches long by 2 to 4 inches wide.

They said that most of this had been put in during a previous period of operation over thirty years ago and it still seemed perfectly sound. In the shaft, or more steeply inclined parts, the sets have four members, the sill pieces serving as a ladder. But as it is not open behind them you barely get a toe or heel hold and it is impossible to wear shoes with stiff soles underground.

The shafts start down at an angle of 70° or more and proceed by a series of spirals and zig-zags. Sometimes the working is nearly horizontal, at others vertical, and in some cases takes an up grade for a time, as the miners follow the ore with no fear of litigation on the charge of trespassing. From this main entry numerous little galleries led off to either side where they had followed some little stringer of poor ore. These they call "guides," and they say that these never fail to lead them to a rich lens or pocket of ore.



A Chain Bridge used in Western China.

The zinc is all carbonate. The lead is principally present as galena, often in seams of loose sand or soft mud, and most abundant in the lower workings. They have no trouble with water and are thus able to work to considerable depth. When within about 30 ft. of the bottom our lights were put out by carbon dioxide, but one of the men climbed down and chipped off samples of the "lead guide" they were following. When the gas collects in their shaft, they blow it out with a small fan until it gets too bad even for this. They then have to abandon the work until a more favourable season. No explosives are used. The ore is all carried out on men's backs in bamboo baskets. The men receive 100 small cash per day and rice, or about 3d. per day, and in this mine they make four or five trips a day.

The ore is carefully hand-sorted, and the lump zinc ores are divided into four grades according to the texture and size. The fines are washed in hand screens. A little of this is smelted at the mines, but most of the smelters are established at the coal mines by the river, about five miles from the mines. The zinc furnaces hold from 48 to 72 fire-clay pots, 6 inches diameter at the top and tapering to 1 or 2 inches at the bottom, and 18 inches deep. The ore receives no preliminary calcining, but is mixed with coal and filled into the pot. A cylindrical extension 6 or 8 inches long is luted on the top. A small stick is placed against the side of this to provide a passage for the zinc vapour, and a layer of fine moulding sand is packed in and scooped out to form a little cup to receive the condensed zinc. A flat fire-clay cover is placed on top and luted all round except for a little hole on one side for the gases to escape through, and the pot is then ready for the furnace. They put through one charge per 24 hours. The pots cost about 1d. each and last about 30 charges. The yield from these ores is 1 to 1·5 catties of zinc per pot. It requires four men to operate each furnace of 72 retorts. At present all the zinc is being sent to Yunnan-fu for export, because the manufacture of cash had been suspended on account of the high price of zinc.

The lead ores are smelted in small mud shaft furnaces, with a depth of charge of 3·5 to 4 ft. The normal charge consists of 2 parts ore, 1 part coke, and 1 part rich slag. The blast is supplied by a large piston bellows of the usual Chinese type, operated by eight men in two relays. As the charge smelts it runs down into a little fore-hearth scooped out in front of the furnace. The slag cools on top, forming a crust, which is raked off from time to time. The upper part is discarded, while that next to the lead is saved for re-smelting. The lead is ladled out once a day. These furnaces remain in blast from 10 days to one month, when they require re-lining and general repairs.

All of this lead contains more or less silver, and when it runs 10 or 12 taels or over per ton it is cupelled. As far as I could gather that seemed to be the economic limit below which cupellation cannot be conducted profitably. The cupels are oval in shape about 4 ft. by 3 ft., and made of wood ash. Straw is laid on the bottom of this, and then the charge of about half a ton of pig lead; then a clay arch is built over the longer axis, and a grate of fire-clay rods extends from this arch to the rim of the cupel. A mud dome is built over the cupel, and live charcoal is filled in on top of the grate. The cupellation requires two days. The litharge is reduced in a shaft furnace. Most of the lead is sent by pack train to Sze-chuan.

At Tung-chuan, which is a pretty little city with many fine old trees, nestling in a fertile plain among lofty mountains, we visited the government copper refinery and cash foundry. The copper comes principally from the district southwest of the city along the Yangtze. A little native copper is obtained, but most of it comes from oxide and rich sulphide ores. These are smelted to blister copper at the mines and brought to Tung-chuan by pack mule.

The refining furnaces are built in pairs, one of which is operated every other day while the other is being re-lined. They are built of rough sandstone blocks, and the crucible, of mud, about 2 ft. diameter by 20 inches deep, holds a little over 1000 catties of copper. Over this is a sandstone arch which supports the fire of coke and charcoal. In the back wall there is a tuyere opening through which air is blown downward on to the surface of the molten copper. Small pieces of charcoal that fall through the grate above along with the scum of oxides are raked out through a small opening in front. The melting and refining takes 8 to 10 hours, and a new crucible has to be built each time. The process is, I believe, a Japanese one, with probably some slight modification.

The skimmings are crushed under a large stone roller drawn by a water buffalo, as shown, and washed in a sluice for the recovery of any copper it may contain. The tailing is flushed into a ditch outside the wall, where a number of old women pan them again, getting a little copper and much partly burnt coke.

There are four pair of furnaces in operation. Two of these are supplied with air from the usual Chinese blowers. The other two are supplied from two blowers operated by the most dilapidated steam engine I have ever seen. This engine was supplied from three upright boilers all under steam at 36 lb. pressure. From the look of them I should not care to try to raise the pressure. The coal all has to be brought a two days' journey by pack mule. I should like to know the relative cost of operating the two units.

We took a look round the cash foundry adjoining the copper refinery. It was closed, and all there was to see were a few of the moulds, with a double row of cash and the feeder down the centre. After the cash are broken off, the rough edges are filed on a small foot-lathe. They say that they cast 250,000 cash per day when running.

Here I was told about an attempt to open a gold mine about ten miles from the city, but when the ore was put in the furnace it all volatilized, leaving no residue of any kind. They could not describe the ore at all, and they had no specimens. When I offered to send a man for some, they told me it was all gone now. Evaporated, perhaps! Suitable for a certain type of promoter! At Hui-li-chou I heard about evaporated ores again, but this time it was a copper ore.

We crossed the Yangtze by the ferry at Meng-ku, where it flows through a narrow valley 4000 ft. deep. In descending to the river the road in several places passes through a tunnel about 7 ft. high by 6 to 8 ft. wide cut out of the limestone parallel to the face of the cliffs, and lighted by means of small holes broken out every few feet. It is hot in the valley. Sugar-cane flourishes and the town of Meng-ku has a sugar industry. The sugar is brown and is made into little disc-like patties two of which are tied together with a straw, thus resembling the maple sugar of Canada, but in appearance only. It took us about half a day to get across the river, as the ferryman lives on the other side, and we had to sit on the bank and fire a gun until we attracted his attention. Then we waited an hour for him to get across only to find that he had not brought his boat for horses. He would have to go back and eat his morning meal, and do a few odd jobs, and then he would come over again. The river runs very fast here, and although not more than about a quarter of a mile wide, it carries you down about a mile in crossing. The climb out of the valley took most of the remainder of the day, and was I think without exception the hardest part of the trip. We had an almost vertical sun beating down into the valley and not a breath of air.

The country between here and Hui-li is wild and picturesque, but little travelled. For two days we were among the semi-independent Lolos. In one village we found them celebrating a victory over the Chinese forces from Chiang-yi-pa. As they are all inveterate drunkards, the corn whisky was flowing freely, so we excused ourselves and got away as quickly as we could, but not without having a few stones thrown after us. On arriving at Chiang-yi-pa the official told me how he had crushingly defeated this savage chief. These Lolos I believe are not recognized by the true type of Independent Lolo land, but they are a fine stalwart race. Their women compare well with European women in size, and some of them are good looking. They wear a plaited skirt of full length, a short jacket, and felt hat. The latter is flat and looks much like a tam-o'-shanter. They are called Lolo by the Chinese, except when they are called 'Mantze,'

Crushing Skimmings from Copper-Refining Furnace at Tung-chuan.

which means an ignorant savage. Their proper name is Nosu, which they always call themselves, and I believe they resent being called Lolo.

Hu-li is the centre of an important mineral district, perhaps the best mineralized district in the province, but at present they are interested very little in anything but copper. Most of the mines are south of the city, but they also bring in copper from a distance three days to the north. Many of the mines were closed for the summer, and the others were having much trouble with water. In one of them they had 48 pumps working in 24 lifts, with two pumps on each lift. They said that in the winter one pump for each lift could handle all the water, but now two were having much difficulty to handle it. As there was not room to put in a third, they would have to close if the water became any worse. Besides copper they are also mining iron, coal, silver-lead-zinc, mercury, and gold-bearing quartz. Much placer-mining is done in this district. They also have antimony, and I am told nickel, but these are not being worked. There is another government copper refinery here, on the same lines as that at Tung-chuan minus the steam engine. Instead of crushing and sluicing the skimmings and returning the concentrate to the refining furnace, they smelt them in a small shaft-furnace. The copper is all sent to Cheng-tu by pack mule at a cost of 5 taels per 100 catties for freight, or about £11 8s. per ton.

Leaving Hu-li we were once more on a big road, but it reminded me more of the bottom of a sluice-box with boulder pavement. For it was paved with round, smooth igneous boulders of all sizes, and any earth that had been put over them to fill up the spaces had long ago been washed away. At Pai-kou-wan we visited one of the most important lead-zinc deposits in Sze-chuan. The geology and mineralogy is practically the same as that of the deposits along the Yunnan Kwei-chou border. The metallurgical practice is identical, except that the average yield per retort is lower, due to poorer ores. Their retort pots are of an inferior grade, and only last 15 to 20 charges. I found the smelters feeling angry because they have to sell all their zinc to the government mining office for 3·50 taels per 100 catties, while the price in Yunnan-fu at the time was 28 taels and the freight could not be over 5 to 6 taels at the most.

They are mining gold-bearing quartz at Wa-li and Ma-ha, but as the Gold Mining Bureau had just taken these over, there was little work being done, as nobody seemed clear how it affected them. At Ma-ha they have part of a milling plant, which was installed some twenty years ago, and was the first attempt at using foreign machinery in Sze-chuan so far as I know. I believe it ran for a time and is reported to have made money, but lay idle for many years until July 1914, when the government in Cheng-tu decided to put it in commission again and appointed Mr. Lew, a graduate from Liége, manager. At the time of my visit he had just succeeded in replacing lost parts, and cleaning off years of rust, when word came from Cheng-tu to close down and return to the capital. This property was visited by Dr. R. Logan Jack in 1900.

At Yen Yuan they produce salt, which is white compared with that from Tze-lui-ching. The natives say that using this white salt causes goitre. Whether there is anything in the salt that might cause it or not I do not know, but all the way from Chao-tung to Ning-yuen we noticed that the majority of the people were affected with it, and practically none of the Tze-lui-ching salt gets south of these two cities. In the salt-well district here they use a small cash that is if possible even smaller than those made in Tung-Chuan and change 2300 to 2400 for a dollar.

I was rather disappointed in the Chien-chiang valley, about which I had heard so much, but Ning-yuen is a beautifully situated little city. Nestling on the gentle slope of a spur of the main hills it looks out over a pretty lake, beyond which the mountains rise to 14,000 feet. The crest of the hills all round marks the border of Independent Lolo-land. Those who live without the city wall are in constant dread of Lolo raids. It is indeed pitiable to see a village of perhaps fifty houses raided by ten or twelve Lolos, and one or two homes stripped of everything movable, and the young and able-bodied members of the family carried off as slaves, while the rest of the village bar their doors and hope that they may escape. But they seldom do, for probably the very next night another house is raided, and so on until often the whole village is cleaned out. This lack of co-operation, even for mutual defence, is one of the greatest drags on the wheels of progress in China. And while much is written and talked about the danger from Japan and other foreign powers, China's worst enemies are to be found right in their midst, deeply rooted in the very soul of her own millions. For if these could be eradicated there would be no need to fear any foreign power.

At Ching-Chi-hsien we joined the main road from Ta-chien-lu, and from here into Ya-chow we met a continual stream of packers carrying brick tea for the Tibetan trade. They carry great loads, sometimes well over 300 lb., and make short stages. And besides this load of tea each man must have one measure of rice, 30 catties, for the troops before he can pass the li-kin station at Ya-chow. After crossing the Big Pass, which is only a little over 9000 feet, but has a climb of 6000 feet or more on either side, we were in the Ya-chow district. This is a well mineralized district and much more accessible than the Hui-li district. I hope to be able to make a much more careful survey of it in the near future. They are at present mining lead-silver, zinc, iron, copper, antimony, anthracite, and bituminous coal in the district, as indicated on the accompaying map.

Leaving my interpreter at his home in Ya-chow I pushed on, arriving in Cheng-tu on September 2, bringing to a close an exceedingly pleasant trip, during which I managed to see a good deal of the country, in a hurried way, and at very little cost. We practically lived on the country as we went along, and with the tea, coffee, cocoa, sugar, milk, a few tins of biscuits and cheese we carried, we had no complaint to make, thanks to my boy, who is an expert at making the best out of nothing, and with nothing as it often appeared to me. After selling our ponies the whole trip cost just about £50.

We were given a most hearty welcome by all the French, American, and British missionaries along the way. And it was indeed pleasant after a couple of weeks of no other company than my interpreter to hear a foreigner say, "Come right in ; I know you want a bath, and the boy will have a big one ready in a minute." They all assured me that the pleasure was mutual, for in some cases I was the first foreigner to visit their district for over a year. They all appeared to be widely known and held in high regard by the Chinese. I was received in a most friendly manner by both officials and business men throughout the entire trip, and I saw no signs of any anti-foreign feeling among the people. Several times I was told that they would rather I had been an American, for I found that we Britishers were in disfavour just then on account of our alliance with Japan, and on account of the almost universal belief that it was only because Great Britain was backing Japan that she was so insistently pressing her demands at Peking.

Throughout I have given an approximate gold value based on exchange at the time of my trip ; and for the further information of the reader I may say that the silver dollar, which is the nearest approach to a standard coin in China, is the Mexican dollar or its equivalent. But each province still mints its own dollars, which are at a slight discount outside the province. The standard is usually given as the tael, a Chinese ounce of silver, but the ounce and the fineness of silver differ so much in different parts of the country that I find it much more satisfactory to get quotations in dollars, which as I have said, are practically uniform. Then the exchange between taels and dollars varies considerably in any one place along the coast, but in the West it has been fixed at 0·71 taels in Sze-chuan and 0·70 in Yunnan for a dollar. In the country districts all small business, and often much larger affairs also, is all done in copper cash. The cash exchange for a dollar has been rising rapidly of late owing to the minting of great quantities of 20, 50, 100, and even 200 cash pieces, which are not themselves worth that amount in small cash. But the government, realizing the mistake of debasing the currency, has been trying to remedy this by restricting the various mints to an issue of so many copper coins a year. When I arrived in Cheng-tu on December 1912, just after the revolution, I was told that 1170 cash for the dollar, which we were getting then, was high. But it has continued to rise until at the time of writing, May 1916, it is over 1700. During the summer of 1915, when these notes were made, it averaged about 1400. Naturally the cost of living, figured on a cash basis, has risen enormously in the last few years, but, as in many other countries, the wages have not advanced in proportion. And while it is probably true that nobody starves in Sze-chuan, there are many living on the ragged edge all the time.

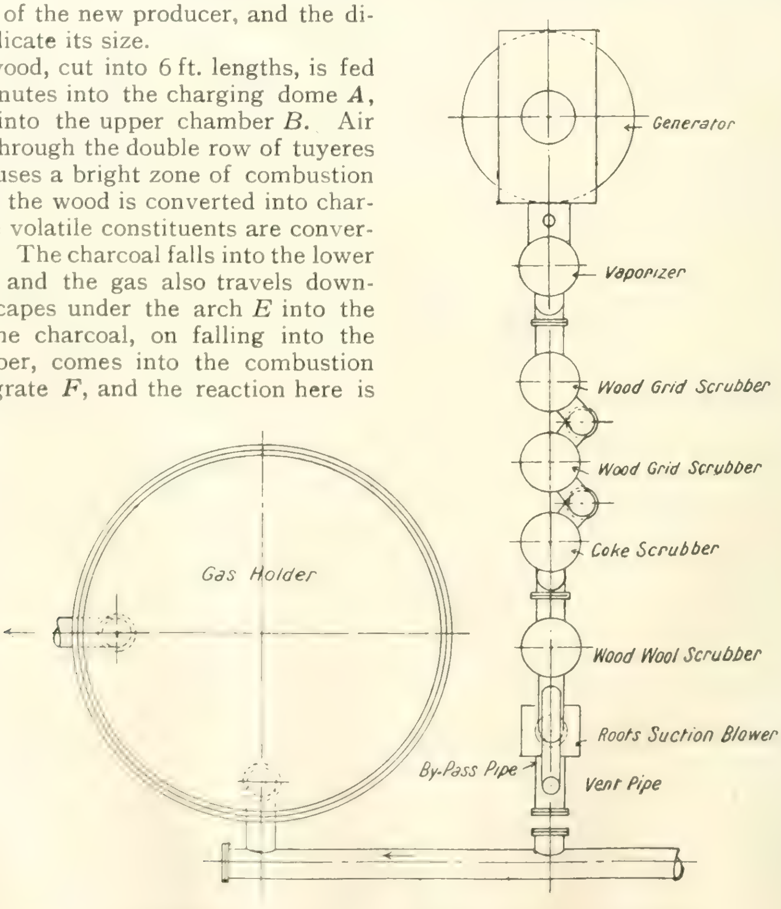
Elsewhere in this issue, Mr. Ernest Williams recommends concrete-lined shafts for a big scheme of development of the Far East Rand. In this connection an article in the *Mining and Scientific Press* for October 7 is of timely interest. This article describes the concreting of one of the shafts of the Copper Queen mine in Arizona, the work having been done without interfering with the traffic. In commenting on the article, the editor describes the reorganized shaft as a fire-proof, waterproof, permanent main artery of traffic from mine to surface, and reminds us that for an extensive ore deposit the concrete-lined shaft is far more efficient and cheap than anything else.

WOOD-GAS PRODUCER AT THE HAMPDEN MINE

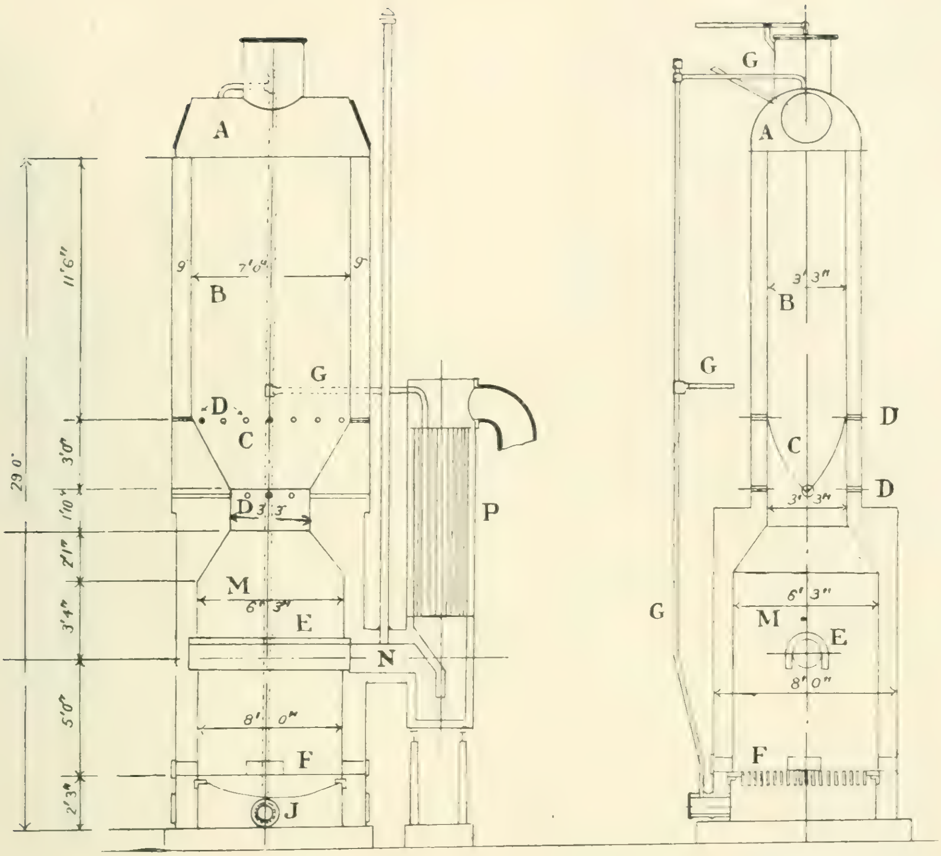
THE wood-gas producer described in this article was designed for the Hampden mine and smelting plant, operated by the Hampden Cloncurry Copper Mines Limited, in which company the patent rights are vested. The following description has been compiled from notes supplied by Mr. Erle Huntley, the inventor of the producer, who is manager for the Hampden Cloncurry company. The producers used previously burnt charcoal, which was costly ; so experiments were undertaken with fire-wood. The new producer was designed on the plan of having two zones of action, an upper zone in which the oils, tar, and other hydrocarbons are converted into gas and the wood into charcoal, and a lower zone in which the charcoal is attacked. The gases from the two zones are withdrawn through a port in the upper part of the lower zone. The accompanying illustrations show the general construction of the new producer, and the dimensions indicate its size.

The fire-wood, cut into 6 ft. lengths, is fed every 20 minutes into the charging dome *A*, and it falls into the upper chamber *B*. Air is admitted through the double row of tuyeres *D*, and it causes a bright zone of combustion at *C*. Here the wood is converted into charcoal, and the volatile constituents are converted into gas. The charcoal falls into the lower chamber *M*, and the gas also travels downward and escapes under the arch *E* into the pipe *N*. The charcoal, on falling into the lower chamber, comes into the combustion zone of the grate *F*, and the reaction here is similar to that in an ordinary charcoal gas-producer. The grate *F* is supplied with air through the pipe *J*, and with steam through the pipe *G*. Steam is supplied to the top of the chamber *B* through the pipes *G*, in order to prevent explosions on the opening of the top dome during feeding, especially when very dry wood is being used. The careful application of steam in the top chamber is of importance with wood of varying dryness. The gas from the charcoal passes also through the pipe *N*. The gases from the two chambers, uniting in this pipe, go through tubes in a cooler *P*, and afterward go to the usual scrubbers and filters, where dust and heavy hydrocarbons are removed. The cooler *P* is fed with water, and provides sufficient steam to supply the top of the chamber *B* and the grate *F*.

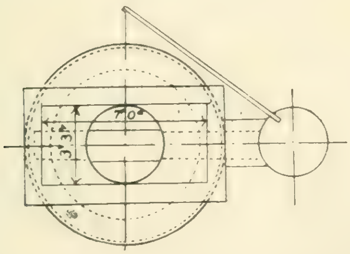
The gas-power plant at the Hampden mine consists of three Kynoch tandem engines, each



DIAGRAMMATIC PLAN OF THE PRODUCER AND CLEANERS.



Sections and Plan of the Producer.



of 280 brake horse power, and two Hornsby duplex engines, each of 180 brake horse power. The installation of gas producers using charcoal were three in number, and were rated at 500 horse-power each, two being in use at a time. The average power production was 800 h.p., varying from 700 to 950. The first producers were adaptable for either charcoal, coke, or anthracite, and were used on charcoal as already mentioned. The cost of charcoal and anthracite was about £4 per ton, and of coke from the gas works £3. 10s. per ton. The cost of fire-wood is about 17s. per ton. The gas obtained by using charcoal was of good quality, the calorific value being 132 British thermal units per cubic foot. The consumption of charcoal averaged 19,410 lb. per day, or 800 lb. per hour, which was approximately 1 lb. per horse-power-hour. The cost of the fuel averaged £34. 13s. per day, equal to £15. 13s. per horse-power-year, or 0·43 pence per horse-power-hour. The wood-gas producer proved much more economical. The first unit is rated at 800 horse power. It has reduced the cost of fuel to £16. 8s. per day, equal to £7. 5s. per horse-power-year, or 0·2 pence per horse-power-hour. The consumption of fire-wood is about 41,400 lb. per day, equal to 2·16 lb. per horse-power-hour. The gas produced has an average calorific value of 120 B.t.u. per cubic foot. The wood-gas has a slightly lower calorific value than the charcoal gas, but on the other hand the gas engines work more equably on the wood-gas. Both the Kynoch and Hornsby engines have produced their power more regularly, and there has been no interruption of power-supply due to engine trouble.

DISCUSSION

The Far East Rand.

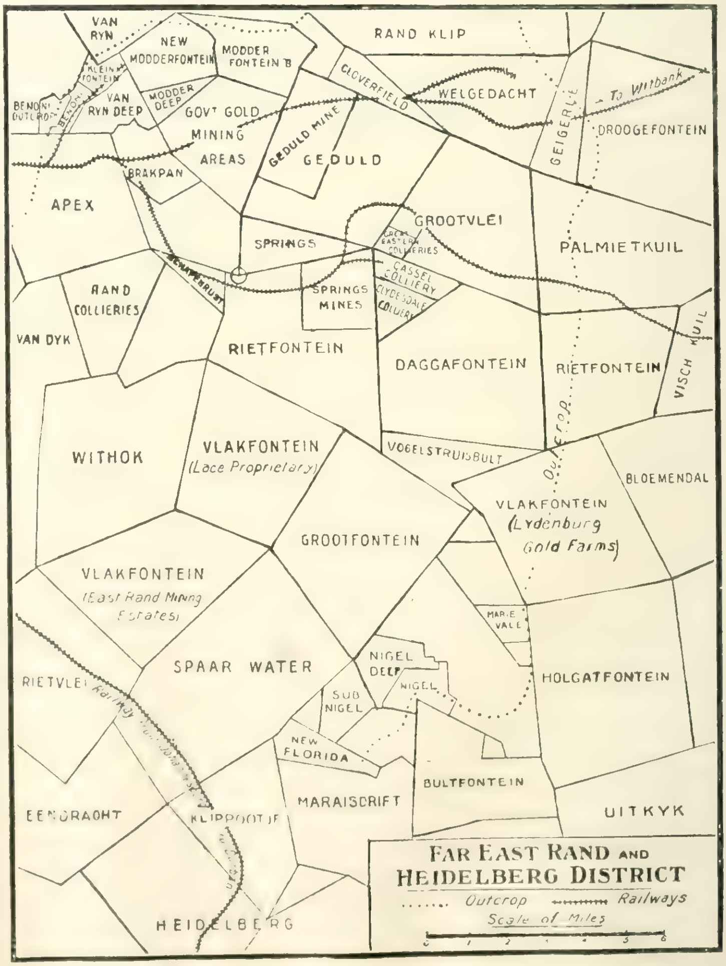
The Editor :

Sir—The increasing interest now being taken in the future possibilities of this district is indicative of the feeling growing in many quarters that the production of gold from the developed Rand areas is arriving at its zenith. So far we do not know another goldfield able to maintain the world's progressive gold production. In view of this feature the development of the known auriferous beds of the Far East Rand appears to be an economic necessity and a national duty. Failure to meet the world's demand for the precious metal will accentuate the grave difficulties in international commerce that are certain to follow the unparalleled disturbance of trade conditions as yet only faintly observable.

At this moment there is no definite scheme before the general public bearing on the exploitation of the Far East Rand gold deposits on a scale at all fitting the demands of the situation. It is not likely that private capital will come forward in the old-style manner, or that the Government will embark upon a State venture in working the area. The reasons in each case are too well known to need to be re-stated here. The State, however, may be induced to inaugurate a new departure in gold-mining enterprise, and to facilitate the development of this field on a scale only possible when done under Government auspices.

The State has not so far brought forward any acceptable proposition for the development of the Far East Rand, and is indeed still inquiring into the best methods of tackling the question. Under these circumstances I feel warranted in making a definite proposal embodying State aid. My proposal is as follows:

The southwestern corner of the unproclaimed Government farm "Springs" may be taken as the central point of a representative area, which under ordinary circumstances would satisfy the requirements of a number of operating gold-mining companies. Near the south beacon of the western line of the Springs farm a good shaft position can be secured. This point is marked with a circle on the accompanying map. Here it is suggested



that a set of twin or perhaps triple shafts be sunk of a size sufficient to meet the requirements of the large area available. There is no engineering difficulty to be feared in carrying out this work on a scale surpassing anything hitherto attempted on the Rand. No unknown difficulties need be anticipated, and the general conditions under which the work would be carried out are well understood.

The suggested shafts, elliptical in form, should be made in the most permanent manner, carefully sunk with a view to disturbing the shaft-walls as little as possible, all shot-holes to be put in as they were in shaft-sinking in England in former years; the shaft lining to be of re-inforced concrete and all divider shoes to be of galvanized cast steel, fixed in position as sinking or lining proceeds. One shaft should be fitted with a spiral stairway (travelling way) at its inside perimeter. Progress of sinking will of course be slower than is obtained now-a-days on the Rand, but such shafts as outlined would have a much longer life at lower upkeep cost and less repairs.

Following the completion of the shafts the underground station would be proceeded with. This would need to be so laid out that it would serve a number of underground interests, namely, the present and future claimholders in this area. It would assume the character of a railway junction station, where the underground traffic of the several gold-mining companies would be handled with the same precision as traffic at a large railway junction station ; this underground station would be formed within the limits of the necessary shaft pillar. Both shaft and station would be national property.

The shafts and station facilities would now be available for the operations of individual companies. Each or all of them could at once proceed with their development programme with power, lighting, ventilation, and other services ready to hand. In the method adopted by Mr. Stuart Martin at the Modder B. gold mine, the operators have the model system fitting well with the known conditions obtaining over the area to be served by the suggested shafts.

As the shafts and underground station will have been made under Government control, so the operating control of their working would be with the Government; here the example of the Rand Water Board could be followed, the new body having control over the working of the shafts and station.

The financing of the shaft-sinking and underground station could be effected by means of Government bonds issued in payment as the work proceeds, on the lines of some of the large Government contracts carried out in various quarters of the world.

Important favourable conditions would be obtained, such as: availability of the necessary supplies of electric and air power at reasonable rates ; proximity to several important townships where accommodation for white workers may be secured by them ; operations could be carried on at a minimum cost unhampered by individual considerations.

The question of possible economies to be gained under such a scheme calls for special attention. We may confidently assume that actual working costs on the Rand have not reached their lowest point. A low efficiency still obtains in the field of power production and use, and there is room for advance in other mechanical sections.

ERNEST WILLIAMS,
M.I.M.M., Assoc. M.Inst.C.E.

Salisbury House, London,
October 20.

[We refer to the subject of Mr. Williams' letter in our Editorial columns.—EDITOR.]

Minerals in Sze-chuan.

The Editor :

Sir—The article by Mr. Herbert W. L. Way on "The Minerals of Sze-chuan, China," in your July issue is of considerable geological interest. It confirms the opinion, which I formed while working about the boundary of Sze-chuan and Yunnan in 1909, that a marked similarity exists in the geological ages and structure of the two regions, and that the mineral-bearing zones of northwestern and north-eastern Yunnan continue into the northern province. The rocks of the Red Basin of Sze-chuan are clearly related to the extensive deposits of Permo-Triassic age found in Central Yunnan, to which I have given the name "Red Beds Series" (*Rec. Geol. Surv. Ind.* Vol. XLIV., pt. 2, p. 112). These rocks yield the brine which supplies the greater part of the province with salt, though it occurs at shallower depths than the deep horizons of the Red Basin of Sze-chuan. Petroleum and natural gas do not occur in Yunnan, as far as I know.

Mr. Way does not state, in every case, whether the records of the Mining Bureau from which he quotes refer to modern mines or abandoned ones. Official Chinese documents of this kind need most careful analysis. They often magnify the importance of the deposits they describe, and usually include prospects on which no one but a Chinese miner living in his own country can make a living. Further than this, abandoned mines are often added to the lists, so that these become very erroneous indicators of the actual state of the native mineral industry.

Apart from this, it is important to be able to identify the larger abandoned metal mines of the Chinese. It is from the deeper portions of deposits unworkable by indigenous methods that future production will come, once scientific development is undertaken. The limitations of Chinese mining are well illustrated by the case of the Bawdwin zinc-lead-silver deposits of the Northern Shan States.

J. COGGIN BROWN,
Geological Survey of India.

Tavoy, Lower Burma,
September 3.

Education after the War.

The Editor:

Sir—I have read with interest Mr. Berriman's letter in the October number of your Magazine. I think he is wrong in stating that many of those students who start their engineering training in a College "never go through the shops"; if, in place of "many" he had used the word "few," his statement would have been in accordance with the facts. I think that the authorities in the Faculties of Engineering of all our Universities and our Technical Colleges impress strongly on their students the absolute necessity of a shop training, and, so far as my own university (Bristol) is concerned, I can vouch for the fact that nearly all our students, with the exception of some of the civil engineers, receive a shop training. Mr. Berriman advocates that a boy leaving school should proceed at once to a shop before receiving any college training; I doubt the wisdom of this, for a boy then loses at too early an age the habit of study and, in many cases, he is unwilling to take to any course of training beyond the imperfect one he can get while in the average shop, where there is no time to teach the principles underlying his profession. I am aware that in a few works, including those of the Daimler Co., means for giving special training for apprentices are provided, but I am speaking now of the majority of the works which rightly, I think, prefer to leave academic and laboratory training to institutions specially equipped and staffed for the purpose. But on the other hand, I think that, if a student has spent a year in the University, it is better that he should at once have some works experience before completing his course, and, for that reason, I have suggested the Bristol "sandwich" scheme for training engineers. This scheme is described as follows in the official circular published by the University:

"The total length of the course is five years, of which about half will be spent in the University and the rest in a works. The following table shows the plan proposed, as it would affect a student beginning, for instance, in October 1916:

Period	No of Months in Works.	No. of. Months in University.
October 1916—July 1917	—	10
August 1917—September 1918	14	—
October 1918—July 1919	—	10
August 1919—September 1919	2	—
October 1919—July 1920	—	10
August 1920—September 1921	14	—
	30	30

"The idea is that fourteen months in a works at the end of the first session will enable a student to return to the University better qualified to understand the theory of engineering and the laboratory work than is the case with one who has no such experience.

"It is proposed to allow students of promise and excellent character to avail themselves of this arrangement; but it must be understood that, if any student does not give satisfaction during the first fourteen months, he will not be at liberty to return to the works during the subsequent periods mentioned in the scheme; and he will, of course, be liable to dismissal for idleness or misconduct. It is, however, hoped that these safeguards will very rarely take effect."

This scheme has now been accepted by the following firms, and, in view of the character of the list, it is certain that the experiment will be tried under favourable circumstances: The Bristol Wagon & Carriage Co. Ltd.; The British Westinghouse Electric & Manufacturing Co. Ltd., Manchester; The Electric Construction Co. Ltd., Wolverhampton; John Fowler & Co. (Leeds) Ltd., Leeds; R. A. Lister & Co. Ltd., Dursley; Mather & Platt, Ltd., Manchester; Mawdsley's, Ltd., Dursley; The Midland Railway Co., Derby; Plenty & Son, Ltd., Newbury; A. Ransome & Co. Ltd., Newark-on-Trent; Robey & Co. Ltd., Lincoln; Swan, Hunter & Wigham Richardson, Ltd., Newcastle-on-Tyne; John I. Thornycroft & Co. Ltd., Southampton; George Waller & Son, Stroud; Yarrow & Co. Ltd., Glasgow.

J. WERTHEIMER,
B.A., D.Sc., F.I.C.

Faculty of Engineering,
University of Bristol, October 26.

SPECIAL CORRESPONDENCE

CAMBORNE.

DEPARTMENT OF MINERALS AND METALS.—In my last letter I briefly referred to the proposed establishment of a Government Department of Minerals and Metals, which would act as a kind of clearing-house for information relating to the mining and metallurgical industries, and keep in close touch with the mineral potentialities of the various parts of the Empire, and with the metal requirements of the industrial world. The war has proved the need of such a central organization, and as there seems to be a fair possibility of its establishment, it will be well to consider its effect on mining in the West of England. The functions of such a Department would necessarily include : (a) arrangements for expediting the completion of the mineral surveys, (b) the systematic collection and co-ordination of information bearing on the occurrence, uses, and economic value of minerals and their products, (c) the investigation of questions and problems relating to the utilization of the mineral and metallurgical resources, (d) the co-ordination and dissemination of information on mining laws, development of mineral areas, output, processes of extraction, plant, capital employed, markets, etc., (e) generally to advise the Government on all questions bearing on the mining and metallurgical industries. Now in all these matters the West of England is vitally interested. There can be no question that the completion of the mineral surveys of Cornwall and Devon, particularly in comparatively undeveloped districts, would prove of much service. The collection of statistics and other information relating to the mining industry of the West of England would most surely be of great value to engineers and others interested. At present it is nobody's business, for although the Home Office collects exhaustive statistics as to output, etc., these figures are not nowadays issued until 18 months or so after the year to which they relate, and they are arranged in such a form as to be by no means easily interpreted.

Recently, an investigation has been made by the Board of Agriculture and Fisheries into certain granite deposits at Grenville to ascertain if the percentage of potash therein existing could be profitably extracted, but it is unlikely that the information secured will be available for the public, and probably it will be pigeon-holed and forgotten. If the proposed Department of Minerals and Metals had been established, no doubt that body and not the Board of Agriculture & Fisheries, would have conducted the investigations and the whole of the data secured would have been placed at the service of the community.

Then the uses to which the products (and particularly the by-products) of the mines can be put would be brought before the producers, and buyers and sellers would be put in touch with each other. The high losses in tin-dressing would clearly be a subject which would engage the attention of the promised Department, and doubtless it would supersede the present joint Committee of the Institution of Mining and Metallurgy and the Royal Cornwall Polytechnic Society, whose investigations seem not even to be making a start. The present block in negotiations might possibly have been anticipated, had those in London had a more intimate acquaintance with the character of the Cornishman and the conditions ruling here.

Then one might anticipate that the establishment of a Government Department of Minerals and Metals would lead to Government grants for the development of mineral areas, much on the lines of Colonial practice, and possibly to the acquisition of all mineral rights. There are several disadvantages in the Government ownership of mineral rights, but they do not outweigh the advantage of getting rid of the large proportion of landowners who are prepared only to lease their rights on terms which make it almost impossible to raise capital for the opening up of large mineral areas in the county.

Some of the work enumerated above would doubtless have been carried out by the Cornwall Chamber of Mines had it ever materialized, but obviously a Government Department can conduct research work more effectively than a Chamber of Mines of limited financial resources. But the chamber, or some such organization, is still badly needed to represent the view of the industry in the negotiations which are being conducted for the establishment of the Department, and when established, to represent to such the possibilities of the large unworked mineral areas awaiting development within 300 miles of the capital of the Empire.

COLLECTIVE AND INDIVIDUAL EFFORT.—I have frequently had occasion to deplore in these columns the lack of co-operation among Cornish mining interests, and the resultant loss of the many benefits which arise out of co-operative action. The proposed formation of a Department for Minerals and Metals again brings the matter prominently forward, for what body is now able to speak authoritatively for Cornish mining? The proposed Chamber of Mines appeared at one time to have met the fate which Mr. Oliver Wethered expressed the hope might be avoided. At the time of writing, I understand that progress in its formation is being gradually made, and that a draft constitution has been provisionally approved. It would be regrettable if the Chamber was not finally established, as it did appear as if Mr. Moreing had at last succeeded in persuading the mines to surrender their long maintained attitude of splendid isolation. It is to be hoped that those who favour cohesion in the many important matters affecting the West of England mining industry will still persevere, for there is no future for the industry until the petty jealousies and differences can be composed, and Cornwall and Devon can speak with one voice on all general matters affecting the industry. The assumption in Cornwall seems to be that collective and individual enterprise are not compatible, but this assumption is one of those half-truths which do so much to prevent the facts being seen in their true perspective. Collective action does sometimes tend to diminished activity and initiative on the part of the individual, but there is no real reason why it should. In a voluntary system of co-operation, unity of purpose and not uniformity of method is what is sought for. The task of an organization representative of the industry is not to regulate the activities of the several mines, but to co-ordinate them and to indicate their objective. In mining, as in other classes of industrial activity, there are interests—they have been repeatedly referred to in this Magazine—which are common to all the mines. If the mineral resources of Cornwall and Devon are to be developed on a scale commensurate with their possibilities, and if the already established mining industry is to secure concessions in legislative and other matters, then co-operation is the only way. No one mining group in Cornwall or Devon is sufficiently strong to intimidate a Government Department, but a combination of all would command attention.

GEEVOR.—The developments at this mine of late have been so satisfactory that the company has been able to place the balance of its unissued capital, so that, at last, money is available to make the connection with the old workings of Wheal Carne. Mr. R. Arthur Thomas, in his recent report, drew special attention to the Wheal Carne section of the property, and pointed out that at least ten good ends were stopped from development eastward because of the danger of connecting with the old Wheal Carne workings which were under water. The directors intimate that the question of additional crushing machinery is under consideration, but I join with many other well-wishers in expressing the hope that no money will be spent in this direction until the mines have been adequately developed.

CORNISH GRANITE.—A good illustration of the need for a Government Department which will concern itself with the utilization of this country's mineral resources has recently come to light. The North British Railway Co. required a large quantity of granite for use at certain docks in Scotland and the Government authorized the contract going to Norway, instead of using its authority to influence the order being placed in Cornwall, where granite of equal quality and at much the same price could have readily been obtained. This means sending money out of the country for goods which can be secured at home, a policy deprecated by the Government itself, and of course, it means using up shipping which, from a national standpoint, could be more profitably employed. The Minister in charge of the Board of Trade admitted he knew nothing of the matter when his attention was drawn to it, but it should be the policy of the Government to assist home production whenever reasonably possible, and to keep in close touch with producers and consumers.

BASSET.—The improvement at this mine reported at the recent shareholders' meeting is now beginning to show itself in the sales, as the following figures culled from the tin-ticketing papers demonstrate:

September	11	22 tons
,,	25	25 ,,
October	9	27 ,,
,,	23	29 ,,

This company is working on the Great Flat Lode which was so productive in the upper levels of Basset, and also in Grenville and other mines. The improvement in the bottom, now that the poor bar of ground appears to have been got through, must be particularly pleasing to Mr. Francis Oats, who has shown his unbounding faith in the property for so long, and in such a substantial manner. The output from the mine is ridiculously small when considered in relation to the heavy standing charges. It is, however, quite out of the question at present to secure more miners, and unless the existing force can be got to break more ground per man, no increased output can be expected, at any rate until after the war.

JOHANNESBURG.

FAR EAST RAND.—Although the Far East Rand still claims more attention than the rest of the Rand put together, the interest locally seems to be on the decline. The advertisement calling for tenders for certain unlet portions of the Brakpan and Modderfontein farms revived attention for a short time, but the appointment of a Government Commission to inquire into and report upon the question of State Mining has reduced public interest to a minimum. This action of the Government in delaying the much needed opening of the mining areas on the Far East Rand by the appointment of this Commission is not over popular, but in the face of the increased public agitation in favour of State Mining it is difficult to see what other step the Government could take. It is becoming increasingly evident that if similar delays occur in the future, the total gold production of the Rand will soon register a decline.

The calling for tenders to lease the unlet portions of the farm Brakpan aroused some interest, although it seems probable that the Brakpan Mines will be able, owing to its position, to offer the best terms to the Government, although the Geduld Proprietary Mines ought also to be in the running. It is believed that for this block several tenders will be put in. The ground is not by any means proved, as bore-holes are notoriously unreliable indications of values. The mines working in the immediate neighbourhood run less risk than strangers, and it seems almost a foregone conclusion that the Brakpan Mines will secure the lease.

There is a little more scope in connection with tendering for the Government ground offered near the Modder B mine, as at least three different companies adjoin the property, although two of them are closed down, and seem likely to remain so for some time. This area now offered on lease might be best taken by Modder B. It will be interesting to notice whether these unworked areas on the Far East Rand are to be divided into certain spheres of influence, and the competition thereby restricted, a competition which formed such a conspicuous feature of claim-dealing on the Rand in the early days. The tendering for the exploitation of these unworked areas in the Far East Rand is under present circumstances attended with considerable risk, which does not seem capable of being reduced unless the Government delays the calling of tenders until the surrounding mines have worked close up to the ground. Perhaps in the future, when many mistakes have been made, some steps will be taken by the Government to prove some of these doubtful areas by driving from the neighbouring mines. It may seem a novel proposition, but if carried out, it would appear to be one of the best ways of reducing the risks to a minimum. [References to this matter are made in our Editorial and Discussion pages. —EDITOR.]

FAR EAST RAND EXTENSION.—At the annual meeting of the East Rand Gold, Coal, and Estate Company, the Chairman drew the attention of the shareholders to the possibility of the Main Reef Series extending into their property known as Vischkuil. Now the farm Vischkuil is situated well to the east of Daggafontein, the farm Rietfontein on which the Albu group have been boring, coming between. [See map on page 282 of this issue.—EDITOR]. On Rietfontein the first bore-hole intercepted the overlying reefs, but the hanging and foot wall of the Main Reef Series came together at the site of the boring without the intervention of the Main Reef Series. The depth at which this occurred was somewhat greater than most competent authorities would expect, and naturally therefore the sub-outcrop of the Main Reef Series may be found a little farther east than depicted by Dr. F. H. Hatch. It can scarcely, however, be expected to extend into Vischkuil, where considerable boring was done many years ago, one of the bore-holes, No. 4, striking an unidentified reef which the Chairman considers might belong to the Main Reef Series. It must not be forgotten that where the whole of the information is obtained from bore-hole information, reliance must be placed on the identification of the beds overlying the reef, as the Government Reef in a bore-hole can easily be taken as belonging to the Main Reef Series. It is quite possible, therefore, that the reef struck in No. 4 bore-hole on Vischkuil may really belong to the Government Series, and not to the Main Reef Series at all. The sinking of a shaft to this reef was an excellent suggestion of the Chairman, as in that case would not only the identification of the reef be facilitated, but if driven on would give reliable information as to its value. It is to be hoped therefore that the suggestion of the

Chairman to sink to and drive on this reef will be carried out without further delay. Should the reef be proved to belong to the Main Reef Series it will show that the Far East Rand goldfield extend much farther east than hitherto expected.

A statement made by the Chairman that it was only quite recently that the Nigel reef was identified as the Van Ryn reef needs some correction, especially as the name of the late Dr. Carrick was mentioned in connection with the matter. As a matter of fact practically all the principal geological authorities for a quarter of a century agreed that the Van Ryn reef and the Nigel reef were contemporaneous. Dr. Carrick was the only geologist of note expressing a contrary view, and before his death he came round to the original way of thinking. It is pleasing to find that those who held views exactly opposite to those of Dr. Mellor now adopt his identification. Had this occurred sooner many thousands of pounds of expenditure in the Nigel district would have been saved.

TRAINING OF MINERS.—Attention is again drawn to the scarcity of efficient miners on the Rand, despite the fact that their wages are probably higher than in any other mining district in the world. No doubt miners' phthisis has a great deal to do with the scarcity of trained miners; many of them have died from this dread disease, while others have found it necessary to change either their vocation or their sphere of occupation.

Much regret is being also expressed that the youths of South Africa do not take to gold mining, and become efficient miners, as in other countries. The fact that practically all the unskilled labour is done by Kaffirs probably accounts for this, for were the youths of the country employed in the gold mines at an earlier age they would, as in other countries, gradually develop into efficient miners. Today Dutch miners only work sufficiently long to earn enough money to enable them to go farming, most of them earning sufficient for this before they become efficient miners. It is true that most of the mines employ youths as learners, but they commence too late in life, and consider themselves efficient miners long before they attain that position. Even the Wolhuter Training School does not meet with the encouragement it deserves, for out of 42 apprentices last year only 15 qualified. It is now proposed to reduce the entrance age to 16, and the period of apprenticeship to 2 years. Another proposal is to extend the principle of Miners' Training Schools throughout the Rand, the expense to be borne by the Government and the mines jointly. Those in charge of the Wolhuter Miners' Training School consider the results so unsatisfactory since the school was started that they have asked all interested to send in suggestions whereby they think better results can be obtained. It is to be feared, however, that the difficulties of inducing the South African youth to take to labouring in the mines lie much deeper than is generally recognized, and it will take many years of struggle on the part of these training schools to attain that success to which they are undoubtedly entitled. So long as natives do the real work in the mines, it will be difficult for white youths to acquire thorough practical knowledge, and there is a good deal in the saying that a miner must be bred a miner to become really efficient.

SAN FRANCISCO.

LABOUR.—It will be remembered that, in September, Congress passed the Adamson eight hour bill for railroads, thus preventing disaster to all industries in the country, which was threatened by a general strike of railway employees. The wisdom of this legislation has been discussed from many points of view, though it is granted that the immediate results were beneficial. A commission has been appointed to study the effect of the law on the operation of the various railroads. Mining would have been greatly affected by an interruption to traffic, as this industry supplies 55% of the total of over 1,000,000,000 tons of freight hauled annually, and contributes 37% of the railroads' earnings.

OLD MINES RE-OPENED.—The re-opening of old mines is frequently reported from many States. Some of these were closed in the days when there was no machinery or process suitable for the ores, mostly of low-grade; others were shut-down on account of litigation or other causes. British readers know how the Plymouth mine in California has come to the front as a leading gold producer. The Old Eureka mine, 8 miles away, kept closed for 30 years by the late Mrs. Hetty Green, is being unwatered. The shaft is in fairly good condition as far as drained, that is, 700 ft. Modern equipment is being erected. The Hardenberg mine, also near-by, is being re-opened by W. J. Loring, for Boston parties. Several other properties in this State are likewise being drained, in fact, the fashion has well set in. One of the most interesting centres for this is that of Leadville, in Colorado. Extensive areas, worked for zinc, lead, and silver many years ago, have been equipped at an expenditure of $1,500,000 for resumption of exploration. All four schemes involve the drainage of large underground openings through shafts to a depth of 1300 ft. For this work motor-driven centrifugal pumps have been found a great success. The pumps are lowered as water recedes, but the motor remains near the surface, the vertical spindle being lengthened each time, thus system giving rise to the name "shoe-string pump." As long as the price of metals keeps high the re-opening of these large Leadville mines should be remunerative. The first one, the Down Town mine, is almost ready for ore extraction.

THE AMERICAN-MEXICAN Commission is investigating the disputes between the United States and Mexico. Early in October an influential group of American capitalists having large interests south of the Rio Grande conferred with the Commission regarding their troubles in operating, caused by the continued revolutions and differences with the United States. How the mining and smelting industry in Mexico conducted by Americans suffered can be seen from the following comparative statement, the figures dealing with 45 companies with plants in 14 states:

	First half of 1916	Same period of 1912
Mexicans employed	6000	62,216
Aggregate pay-rolls (U.S.A. currency)	$3,671,302	$18,726,090
Copper matte and bullion, tons	23,156	74,984
Zinc ore, tons	11,183	46,765
Lead bullion, tons	2,928	70,939
Silver, ounces	6,200,339	31,892,735
Gold, ounces	39,895	252,843

This shows a large reduction in every item. Taxes have also increased as under:

	Constitutional Law, 1912.	Arbitrary Decree, 1916.
Pertenencia	$96.629	$569.738
Export and other dues	1,629,971	7,095,052
Total	$1,726.600	$7,665,710

TORONTO.

PORCUPINE.—Owing to alterations in the plant the production of the Dome Mines during September disappointed the anticipations of those who predicted a new high record. The mill treated 38,800 tons of ore of the average value of $4·68 per ton, producing bullion to the value of $179,500. The Hollinger Consolidated Company's statement for the 4-weeks' period ending September 8, shows gross profits of $221,543 from the treatment of 50,177 tons of ore, of the average value of $8·59 per ton. The working costs were $3·62 per ton. The profits again fell short of the amount required to pay dividends, the total deficit being $241,032, but the progress being made encourages the expectation that it will shortly be overtaken. Ore is now being taken from the 1250 ft. level. In sinking a shaft on the North claim of the Acme property an orebody was discovered at a depth of 350 ft. which is believed to be a continuation of a 60 ft. vein struck on the McIntyre at the 700 ft. level.

KIRKLAND LAKE.—The production of the Tough-Oakes for August and September was approximately $175,000, the value of the ore treated averaging $23 per ton. After considerable delay the Lake Shore has completed the installation of a 7-drill compressor and other machinery, which will be operated by steam until electric power is available. The La Rose of Cobalt is operating the Maidens-Macdonald under an option. Two shafts are down 112 ft. and 115 ft. on a high-grade vein. Machinery is being brought up from the old University mine at Cobalt. The La Rose has also taken options on the Hurd claims 1½ miles south of the Tough-Oakes and will shortly begin development. The vein on the McKane property, under option to the Beaver, on the 300 ft. level, is now 40 ft. wide and is stated to carry $12 ore. The shaft is being continued to 400 ft.

COBALT.—During September the Nipissing mined ore of an estimated net value of $236,873, and shipped bullion from Nipissing and custom ores of an estimated net value of $413,753. The quarterly statement of the Timiskaming for the term ended September 30 shows silver on hand to the amount of 707,287 oz. and cash $25,074. The main shaft has reached a depth of 1325 ft. and has about 300 ft. farther to sink before reaching the lower contact between the diabase and Keewatin formations. Two veins recently found at the surface on the Hudson Bay show much improvement on stripping, one of them carrying as high as 4500 oz. to the ton.

KOWKASH.—The Tash-Orn Gold Mines Ltd., the stock in which is mainly owned by Americans, has secured the most promising and important claims in the Kowkash district. It has 14 locations in the Tashota section including the Devanney-Morrison and the Wells claims. On the latter a good deal of work has already been done. A shaft is down 20 ft. on a vein showing abundant free gold and will be sunk to the 200 ft. level. On the Devanney-Morrison the quartz-schist vein at a depth of 18 ft. is 7 ft. wide, and diamond drilling shows considerable improvement at depth. The Tash-Orn has also a controlling interest in the King Dodds claim where some further discoveries have been made, and will continue development during the winter.

PERSONAL

Readers of the Magazine are invited to announce their movements and appointments in this column.

ROBERT ALLEN is leaving London for Rhodesia on November 25.

Lieutenant C. H. BANKS has recovered from wounds, including a fractured skull, received while serving with the Tunnelling Corps of the Royal Engineers.

H. C. BELLINGER has gone to Chile as assistant consulting engineer for the Chile Exploration Company at Chuquicamata.

CHARLES BOISE, manager, and DONALD B. DOYLE, assistant manager, of the Kasai Diamond Fields Company have returned to the Belgian Congo.

W. J. BONNIN has become a partner in the firm of Laws, Rumbold and Co. He has for some time been London manager for the firm.

J. W. BRYANT is with the 258th Company of the Royal Engineers, and serving in France.

J. MORROW CAMPBELL is expected home from the United States this month.

G. W. CAMPION is returning to the Taquah mine, West Africa.

HENRY F. COLLINS has resigned the executive management of the mines and affairs of the Huelva Copper and Sulphur Mines, Ltd., in Spain, and is now consulting engineer to the company, which position has been vacant under his management, but has now been re-created for his occupation. His office will be at 66 Finsbury Pavement, London, E.C.

HARTWELL CONDER is at Zeehan, Tasmania, in connection with settling a suitable site for the new zinc works which the Mount Lyell company is to build for treating the Hercules Rosebery ores.

WILLIAM CULLEN, manager of the Modderfontein dynamite factory, is back at his post, after having been in England on service for the Munitions Department.

MAJOR E. B. CURRIE, in command of one of the Tunnelling Companies, has been home on short leave.

NELSON DICKERMAN, of San Francisco, is visiting Chile and Bolivia.

MAJOR J. H. DOBSON has been awarded the gold medal of the South African Institution of Engineers for his paper on the Johannesburg municipal electric power station.

A. E. DRUCKER recently left London to settle in New York. His address will be 1502 Pacific Street, Brooklyn.

F. LYNWOOD GARRISON has returned to Philadelphia from Brazil.

E. H. GARY, chairman of the United States Steel Corporation, has returned to America after a visit to China and Japan.

MAJOR ARTHUR M. GRENFELL has been awarded the D.S.O. for conspicuous gallantry.

EDWIN HIGGINS has left the service of the United States Bureau of Mines and has started practice as consulting safety and efficiency engineer at San Francisco. He was at one time on the editorial staff of the *Engineering and Mining Journal*.

W. D. HOLE, late of the Poderosa mine, Chile, is at government explosives works in Shropshire.

THEODORE J. HOOVER left on October 21 by the *Philadelphia* for the United States.

L. O. HOWARD, formerly superintendent of the Old Dominion smelter, is now in charge of the International Smelting Co's plant at Miami, Arizona.

AUSTIN W. HOY, London manager for the Sullivan Drill Company, has returned from a short visit to the United States.

ARTHUR W. JENKS has been appointed smelter manager for the Burma Corporation.

S. B. JOEL has arrived on the Rand from England.

JAMES F. KEMP, professor of geology in Columbia University, New York, has improved in health, but has been granted leave of absence for another year.

A. E. KITSON, Director of the Gold Coast Geological Survey, is returning to West Africa.

H. H. KNOX, of New York, consulting engineer and geologist to the Irtysh Corporation, has gone to Siberia.

MAJOR H. W. LAKE, of the Army Service Corps, has been in London on short leave from the front in France.

G. MACFARLANE has left for Australia and is calling at Burma on his way out.

F. E MARCY, inventor of the Marcy mill, has opened an office at Atlas Building, Salt Lake City.

E. P. MATHEWSON, for so long identified with smelting at Anaconda, has resigned to become general manager for the British American Nickel Co., which owns the Murray and other nickel mines at Sudbury, Ontario.

W. W. MEIN is visiting the Mother Lode, California.

F. P. MENNELL is going to Rhodesia shortly.

ALBERT H. MORRELL has been appointed mine superintendent for the Central Chili Copper Company.

ELDER NANCE has been invalided home from the Front.

CAPTAIN J. W. NEWBERY has been awarded the Military Cross.

H. E. NICHOLLS is returning to Northern Nigeria.

A. G. PLEWS has left for Burma.

D. RENOUF is returning from Naraguta to Jersey, Channel Islands.

R. E. RICKARD, lately with the Seoul Mining Co., Korea, has returned to England to join the forces.

W. J. C. SCRUTTON has resigned the position of manager of the Aroa copper mine in Venezuela, belonging to the South America Copper Syndicate, owing to ill-health. He had held the post since the inception of the company in 1907.

DUNCAN SIMPSON, lately at the Wanderer mine, Rhodesia, is with the King's Royal Rifles, and is stationed at Queenborough, Kent.

L. A. SMITH, of Redjang Lebong, Sumatra, has been appointed an inspector of mines for the Federated Malay States.

HENRY C. TAYLOR has left for India on a periodical visit to the gold mines.

HERBERT THOMAS, editor and proprietor of the *Cornish Post*, was in London last week.

D. A. THOMPSON has left for the Abosso mine, West Africa.

HORACE TREMLETT has returned from South Africa.

J. B. TYRRELL has been examining the Rice Lake gold district, Manitoba.

H. C. WOOLMER will retire from the management of the Spassky and Atbasar mines at the end of the year, and will then be appointed managing director of the company.

We regret to record the death of RICHARD STANTON, a mining engineer of wide experience in many parts of the world. He was at Rio Tinto for six years, and on the Rand for four years. Subsequently he was manager of the Sierra Morena copper mine in Spain. He was also known in South America, having been manager of the Copaquire mine in Chile and more recently manager of the mines of the San Antonio de Esquilache company in Peru.

METAL MARKETS

COPPER.—Prices in October have moved in an upward direction, the market indeed having shown great strength. There is a continuous heavy demand for the better class brands of electrolytic and refined copper, especially in America, where the greatly increased production finds ready absorption among domestic trades. Cash standard has risen from £121 to £124, but the greatest strength has been in best selected sorts, which are quoted at £148 as against £143 at the beginning of October. The various Allied Governments have continued heavy buyers for shipment this year and the early part of next. The manufacture of copper wire except for government contracts has been prohibited with a view to freeing further quantities for munitions.

TIN.—There is no special feature to report in this metal, although the price on the whole has been firm, having risen about £7 during the month. America has been the principal buyer and has paid to the Straits far in excess of London parity. At one time the demand in New York was acute and as much as 45c. per lb. (about £211 per ton) was realized for spot Straits. Influenced by New York bids, the East was during the greater part of the month above London parity, but they have lately come more into line with our market, where Straits is being delivered against standard sales.

LEAD.—There is no change in the official quotation, which remains at £30. 10s. to £29. 10s. Very little comes on offer, practically all the supplies arriving going into the hands of munitions suppliers. Some good prices for spot material have been realized for private consumption, but the amount of this trade is negligible. The American market is easier, but their price is still much above English parity.

SPELTER.—The market is steady, and the margin between spot and forward deliveries is narrower, which indicates greater confidence in the maintenance of prices. There is an active inquiry for delivery during the first and second quarters of next year. American producers report a large business for home consumption, and they are now only offering for forward delivery.

ANTIMONY. — Under government control. Price £85 to £95 per ton.

QUICKSILVER.—Spanish unchanged at £17. 15s. per flask of 75 lb.

BISMUTH.—Under government control. Price 11s. to 15s. per lb.

CADMIUM.—7s. 9d. per lb.

PLATINUM.—Under government control. Price given by government 200s. per oz.

NICKEL.—Unchanged at £225 per ton.

ALUMINIUM.—Under government control. Price £150 per ton.

IRON.—Under government control. No. 3 Cleveland pig iron 87s. 6d. per ton. Iron ore not quoted.

MANGANESE.—No current quotations for manganese ores. Last figures published: Indian 2s. 6d. per unit and Brazilian 4s. per unit, both on 50% basis.

TUNGSTEN.—Wolfram and scheelite ores not quoted. Tungsten metal power 6s. 3d. per lb. based on ore at 60s. per unit.

MOLYBDENUM.—Government prices not quoted.

CHROMIUM.—No public quotation for chrome ores. Last figures: £2 to £3 per ton, 50 to 55% Cr_2O_3.

SILVER.—The silver market has been firm during the past month, the movements between 32¼d. and 32¾d. per ounce standard being slight from day to day. At the time of writing, the strength has increased, due to Chinese buying on top of the usual demand for coinage purposes, and the price has gone to 33½d.

PRICES OF CHEMICALS. November 9.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Acetic Acid, 40%	per cwt.	2	0	0
,, 60%	,,	2	18	0
,, Glacial	,,	6	0	0
Alum	per ton	14	0	0
Alumina, Sulphate of	,,	18	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	32	0	0
,, Chloride of, grey	per cwt.	1	14	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	90	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	37	0	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bleaching Powder, 35% Cl.	,,	19	0	0
Borax	,,	33	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	57	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	5	0
Lead, Acetate of, white	,,	90	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	7
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	4
,, Carbonate	per ton	95	0	0
,, Chlorate	per lb.		2	4
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	55	0	0
,, Permanganate	per lb.		8	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	0
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb		1	3
,, Acetate	per ton	70	0	0
,, Bicarbonate	,,	6	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	20	0	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 95%	,,	18	0	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	6	2	6
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	2	15	0
,, Sulphide	,,	22	0	0
Sulphur, Roll	,,	17	0	0
,, Flowers	,,	17	0	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,	15	0	0
Superphosphate of Lime, 18%	,,	5	10	0
Tin Crystals	per lb.		1	4
Zinc Chloride, solution 100°T.	per ton	31	0	0
Zinc Sulphate	,,	27	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,995	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	[illegible]	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767
July	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1915	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9,468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595

Cost and Profit on the Rand

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
July 1915	2,395,397	26 1	17 4	8 7	1,027,332
August	2,418,447	26 2	17 2	8 9	1,056,854
September	2,413,863	26 2	17 4	8 7	1,030,853
October	2,507,662	25 11	17 4	8 3	1,029,972
November	2,433,936	26 1	17 9	8 1	981,229
December	2,410,841	26 5	17 10	8 2	985,361
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247
May	2,382,298	26 7	18 2	8 2	977,263
June	2,296,520	27 0	18 3	8 6	977,681
July	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	333,070	135,289	127,107
July	336,565	322,365	140,290	128,574
August	[illegible]	338,001	139,364	125,143
September	321,085	322,035	135,744	127,138
October	339,967	—	141,771	—
November	313,160	—	122,138	—
December	331,376	—	158,323	—
Total	3,823,166	2,946,363	1,706,473	1,206,219

Western Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181
July	555	98,859	99,414	422,271
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	72,200	18,000
July	154,800	100,600	88,830	85,400	23,000
August	80,300	66,800	93,050	86,000	24,000
September	138,900	115,100	79,470	65,450	32,000
October	111,700	—	91,800	—	—
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	818,000	1,078,560	731,850	285,000

Production of Gold in India

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	191,404
August	193,998	196,560	197,984	192,784
September	191,642	195,843	195,952	192,330
October	194,314	198,191	195,531	191,502
November	192,606	197,699	192,714	—
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	1,908,190

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard	Silver
Oct.	£ s. d.	£	£ s. d	£	£ s. d.	d.
2	118 10 0	141	30 10 0	52	175 5 0	$32\frac{7}{8}$
3	119 10 0	141	30 10 0	52	175 10 0	$32\frac{3}{4}$
4	119 10 0	142	30 10 0	54	176 15 0	$32\frac{9}{16}$
5	119 10 0	142	30 10 0	54	177 10 0	$32\frac{1}{8}$
6	120 10 0	143	30 10 0	57	178 0 0	$32\frac{1}{2}$
9	120 10 0	143	30 10 0	57	178 0 0	$32\frac{1}{8}$
10	122 10 0	143	30 10 0	56	181 5 0	$32\frac{5}{16}$
11	123 0 0	143	30 10 0	56	180 0 0	$32\frac{3}{8}$
12	122 10 0	144	30 10 0	56	180 15 0	$32\frac{5}{16}$
13	122 10 0	144	30 10 0	56	180 15 0	$32\frac{7}{16}$
16	122 10 0	144	30 10 0	$54\frac{1}{2}$	179 10 0	$32\frac{15}{16}$
17	123 0 0	144	30 10 0	53	178 5 0	$32\frac{5}{16}$
18	122 10 0	145	30 10 0	53	178 10 0	$32\frac{5}{16}$
19	123 10 0	145	30 10 0	53	179 5 0	$32\frac{15}{16}$
20	123 10 0	145	30 10 0	54	179 10 0	$32\frac{5}{8}$
23	123 10 0	145	30 10 0	54	180 0 0	$32\frac{1}{8}$
24	123 10 0	145	30 10 0	54	179 15 0	$32\frac{1}{8}$
25	123 10 0	145	30 10 0	54	181 5 0	$32\frac{1}{8}$
26	124 0 0	145	30 10 0	54	182 0 0	$32\frac{1}{8}$
27	124 0 0	145	30 10 0	$54\frac{1}{2}$	181 5 0	$32\frac{1}{8}$
30	124 5 0	145	30 10 0	$53\frac{1}{4}$	181 10 0	$32\frac{1}{4}$
31	124 0 0	144	30 10 0	$52\frac{3}{4}$	180 15 0	$32\frac{1}{2}$
Nov.						
1	124 0 0	145	30 10 0	$52\frac{1}{2}$	180 0 0	$32\frac{1}{2}$
2	124 0 0	145	30 10 0	$52\frac{1}{2}$	180 10 0	$32\frac{7}{16}$
3	124 0 0	145	30 10 0	$52\frac{3}{4}$	182 5 0	$32\frac{1}{2}$
6	124 0 0	146	30 10 0	$53\frac{1}{4}$	182 15 0	$33\frac{1}{8}$
7	124 10 0	146	30 10 0	$53\frac{3}{4}$	183 7 6	$33\frac{7}{16}$
8	124 0 0	147	30 10 0	$53\frac{3}{4}$	183 7 6	$34\frac{1}{8}$
9	124 0 0	148	30 10 0	$54\frac{1}{4}$	184 0 0	$34\frac{1}{4}$
10	124 0 0	148	30 10 0	55	184 15 0	$34\frac{1}{4}$

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	Sept. 1916	Oct. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	3,611	2,466	28,710
,, Matte and Precipitate	38,372	2,110	5,333	37,087
,, Metal (unwrought and part wrought)	180,368	7,118	7,057	93,720
Copper and Iron Pyrite	903,401	56,008	60,290	824,500
Tin Concentrate	44,748	2,724	4,184	30,271
,, Metal	38,896	2,633	2,016	28,612
Manganese Ore	377,324	42,389	38,360	386,754
Lead, Pig and Sheet	256,476	10,171	11,780	130,755
Zinc (spelter)	74,520	5,775	5,716	42,232
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	40,740	62,734	2,500,413

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons.

	Aug. 31, 1916	Sept. 30, 1916	Oct. 31 1916
	Tons	Tons	Tons
Standard Copper in England	1,870	1,379	771
Fine Copper in England	2,969	1,783	2,397
,, ,, Havre	2,675	2,634	2,290
,, ,, Afloat from Chile	850	1,575	650
,, ,, ,, from Australia	3,150	3,000	4,000
Total Visible Supply	11,514	10,371	10,108
Fine Copper in Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1916	Long tons	1916	Long tons
July	16,812	January	21,863	July	35,048
August	16,289	February	20,548	August	34,700
September	14,327	March	24,006	September	28,572
October	26,153	April	19,980	October	32,712
November	19,396	May	14,700	November	—
December	32,936	June	38,277	December	—
Total 1915	257,915			Total 1916	270,406

Stocks of Tin.
Reported by A. Strauss & Co. Long tons.

	Aug. 31, 1916	Sept. 30, 1916	Oct. 31, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,701	1,652	2,201
Ditto, Landing and in Transit	1,175	1,360	657
Other Standard, Spot and Landing	1,260	1,018	887
Straits, Afloat	3,145	3,028	3,405
Australian, Afloat	385	265	225
Banca, on Warrants	—	—	—
Ditto, Afloat	753	840	1,904
Billiton, Spot	—	—	—
Ditto, Afloat	477	423	290
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,291*	1,581*	1,400*
Afloat for United States	4,705	3,000	4,433
Stock in America	4,758	4,769	3,419
Total Stock	19,648	17,933	18,821

* Including 605 tons on board enemy's ships either captured or lying in neutral ports

Shipments and Imports of Tin
Reported by A. Strauss & Co. Long tons.

	Year 1915	Sept. 1916	Oct. 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	1,910	2,455	22,880
Straits to America	31,565	600	2,683	21,203
Straits to Continent	11,024	760	730	7,366
Australia to U.K.	2,481	90	100	2,022
U.K., Holland, and Continent to America	14,967	1,110	1,320	12,788
Imports of China Tin into U.K. and America	3,012	100	—	1,290
Imports of Bolivian Tin into Europe	22,591	1,093	2,700	13,262

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	510
July	140	357	432	455	506
August	201	406	228	438	498
September	196	422	289	442	535
October	256	480	272	511	—
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	4,677

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.

Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	3,517
August	4,454	4,620	3,591	4,046	3,732
September	4,115	4,379	3,623	3,932	3,636
October	3,905	4,409	3,908	3,797	3,681
November	4,112	3,976	4,085	4,059	—
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	36,291

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1911	6151¼	£702,599	£114 4 5
Year 1912	6492	£831,908	£128 5 6
Year 1913	6186	£744,268	£120 2 6
Year 1914	4987	£432,437	£86 14 3
Year 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186¼	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179¼	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10
July 17	186½	£17,114	£91 15 4
July 31	172¼	£16,172	£93 17 8
August 14	166	£15,955	£96 2 4
August 28	180¼	£17,345	£96 4 8
September 11	184	£17,113	£93 0 2
September 25	166½	£15,980	£95 19 7
October 9	197	£19,443	£98 13 11
October 23	170	£17,167	£100 19 9
November 8	194½	£19,701	£101 5 10

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Nov. 5. 1915 £ s. d.	Nov. 6, 1916 £ s. d.
Rand:		
Bantjes	6 3	14 0
Brakpan	3 7 6	4 15 0
Central Mining (£8)	6 10 0	7 0 0
Cinderella	4 3	6 0
City & Suburban (£4)	2 3 9	1 17 6
City Deep	3 8 9	4 7 0
Consolidated Gold Fields	1 7 6	1 15 0
Consolidated Langlaagte	1 17 6	1 8 9
Consolidated Main Reef	1 0 0	18 9
Consolidated Mines Selection (10s).	11 0	1 3 9
Crown Mines (10s.)	3 12 6	3 2 0
Daggafontein	7 9	15 3
D. Roodepoort Deep	15 0	12 6
East Rand Proprietary	1 5 0	15 6
Ferreira Deep	2 3 0	1 6 3
Geduld	1 14 3	2 7 3
Geldenhuis Deep	1 0 0	1 2 6
Gov't Gold Mining Areas	1 8 3	2 12 3
Heriot	2 18 9	2 9 6
Jupiter	6 6	8 0
Kleinfontein	1 4 3	1 9 6
Knight Central	12 6	12 6
Knight's Deep	1 2 6	1 5 6
Langlaagte Estate	18 3	16 3
Luipaard's Vlei	7 9	7 6
Main Reef West	7 0	6 9
Meyer & Charlton	5 7 6	5 3 9
Modderfontein (£4)	15 6 3	18 17 6
Modderfontein B	5 16 3	6 16 3
Modder Deep	5 3 0	7 10 0
Nourse	1 0 0	1 2 6
Rand Mines (5s.)	4 5 0	3 18 9
Rand Selection Corporation	2 5 0	3 15 0
Randfontein Central	11 6	12 0
Robinson (£5)	1 7 6	16 3
Robinson Deep	1 2 6	1 13 9
Rose Deep	1 12 6	1 1 3
Simmer & Jack	8 9	6 9
Simmer Deep	2 9	5 0
Springs	1 8 0	3 5 0
Van Ryn	2 14 6	2 0 0
Van Ryn Deep	2 15 6	3 8 9
Village Deep	1 16 3	1 10 6
Village Main Reef	1 2 0	17 0
Witwatersrand (Knight's)	2 17 6	2 13 9
Witwatersrand Deep	1 8 9	1 3 0
Wolhuter	12 0	10 9
Other Transvaal Gold Mines:		
Glynn's Lydenburg	9 6	13 9
Sheba (5s.)	3 0	1 9
Transvaal Gold Mining Estates	1 10 6	1 2 6
Diamonds in South Africa:		
De Beers Deferred (£2 10s.)	12 0 0	12 12 6
Jagersfontein	3 7 6	4 5 0
Premier Defer'd (2s. 6d.)	5 0 0	5 15 0
Rhodesia		
Cam & Motor	13 6	12 0
Chartered British South African	11 0	11 6
Eldorado	9 6	9 3
Enterprise	5 0	5 3
Falcon	7 9	15 9
Giant	6 3	7 3
Globe & Phœnix (5s.)	1 7 0	1 11 3
Lonely Reef	1 0 0	19 6
Shamva	1 16 3	1 3 9
Wanderer (5s.)	1 3	1 3
Willoughby's (10s.)	5 0	4 3
West Africa		
Abbontiakoon (10s.)	7 6	6 0
Abosso	9 6	9 3
Ashanti (4s.)	17 3	17 3
Prestea Block A	8 9	8 0
Taquah	16 0	19 9
West Australia:		
Associated Gold Mines	3 6	4 0
Associated Northern Blocks	3 3	2 9
Bullfinch	5 9	3 3
Golden Horse-Shoe (£5)	2 0 0	1 16 3
Great Boulder Proprietary (2s.)	15 0	11 6
Great Boulder Perseverance	9	7½
Great Fingall (10s).	1 6	1 3
Ivanhoe (£5)	2 7 6	2 1 3
Kalgurli	15 6	8 0
Sons of Gwalia	14 6	14 0

GOLD, SILVER, *cont.*	Nov. 5 1915 £ s. d.	Nov. 6, 1916 £ s. d.
Others in Australasia:		
Blackwater, New Zealand	15 0	13 9
Consolidated Gold Fields of N.Z.	11 3	5 0
Mount Boppy, New South Wales	7 6	10 0
Progress, New Zealand	5 0	2 6
Talisman, New Zealand	15 0	10 0
Waihi, New Zealand	1 15 0	1 15 6
Waihi Grand Junction, New Z'lnd	19 6	16 6
America:		
Alaska Treadwell (£5), Alaska	6 17 6	2 16 3
Buena Tierra, Mexico	13 9	12 0
Camp Bird, Colorado	8 0	7 0
Canadian Mining, Ontario	9 0	11 3
Casey Cobalt, Ontario	5 9	5 6
El Oro, Mexico	10 6	8 6
Esperanza, Mexico	12 0	10 0
Frontino & Bolivia, Colombia	9 0	12 9
Le Roi No. 2 (£5), British Columbia	10 9	10 0
Mexico Mines of El Oro, Mexico	4 6 3	3 17 6
Oroville Dredging, California	14 6	16 6
Plymouth Consolidated, California	18 9	1 0 0
St. John del Rey, Brazil	16 6	16 6
Santa Gertrudis, Mexico	10 6	10 9
Tomboy, Colorado	1 3 6	1 1 3
Russia:		
Lena Goldfields	1 11 3	1 12 6
Orsk Priority	8 9	1 5 0
India:		
Champion Reef (2s. 6d.)	10 6	7 0
Mysore (10s.)	4 1 3	3 15 0
Nundydroog (10s.)	1 7 0	1 7 6
Ooregum (10s.)	1 3 0	1 1 6

COPPER:

	Nov. 5 1915 £ s. d.	Nov. 6, 1916 £ s. d.
Anaconda (£10), Montana	18 8 9	20 10 0
Arizona Copper (5s.), Arizona	1 11 3	2 5 0
Cape Copper (£2), Cape Province	2 10 0	1 15 0
Chillagoe (10s.), Queensland	6	3
Cordoba (5s.), Spain	4 0	4 3
Great Cobar (£5), N.S.W.	3 0	2 3
Hampden Cloncurry, Queensland	1 9 6	1 17 9
Kyshtim, Russia	1 18 9	2 7 6
Messina (5s.), Transvaal	13 3	11 0
Mount Elliott (£5), Queensland	2 15 0	4 1 3
Mount Lyell, Tasmania	1 2 6	1 7 9
Mount Morgan, Queensland	2 0 0	1 12 6
Rio Tinto (£5), Spain	54 5 0	61 10 0
Sissert, Russia	1 0 0	1 0 0
Spassky, Russia	1 16 3	1 18 9
Tanalyk, Russia	1 16 3	2 11 3
Tanganyika, Congo and Rhodesia	1 6 3	2 10 0

LEAD-ZINC:

	Nov. 5 1915 £ s. d.	Nov. 6, 1916 £ s. d.
Broken Hill:		
Amalgamated Zinc	1 5 6	1 12 0
British Broken Hill	19 0	1 3 6
Broken Hill Proprietary (8s.)	2 4 6	2 14 6
Broken Hill Block 10 (£10)	16 3	19 0
Broken Hill North	1 18 9	2 7 0
Broken Hill South	6 5 0	8 3 9
Sulphide Corporation (15s.)	19 9	1 5 3
Zinc Corporation (10s.)	12 3	16 0
Asia:		
Burma Corporation	1 9 6	4 0 0
Irtysh Corporation	1 13 9	2 4 6
Russian Mining	13 9	18 6
Russo-Asiatic	4 7 6	5 10 0

TIN:

	Nov. 5 1915 £ s. d.	Nov. 6, 1916 £ s. d.
Aramayo Francke, Bolivia	1 7 6	1 6 3
Bisichi, Nigeria	4 6	10 0
Briseis, Tasmania	4 3	4 9
Cornwall Tailings, Cornwall	10 0	—
Dolcoath, Cornwall	6 0	9 9
East Pool, Cornwall	9 0	1 15 0
Ex-Lands Nigeria (2s.), Nigeria	7½	1 7½
Gopeng, Malay	1 7 9	1 10 0
Mongu (10s.), Nigeria	8 9	8 6
Naraguta, Nigeria	8 9	15 0
N. Nigeria Bauchi (10s.), Nigeria	1 6	3 0
Pahang Consolidated (5s.), Malay.	6 9	11 9
Rayfield, Nigeria	3 0	8 0
Renong Dredging, Siam	18 9	2 1 3
Ropp (4s.), Nigeria	13 9	17 9
Siamese Tin, Siam	2 15 0	2 12 6
South Crofty (5s.), Cornwall	4 6	14 6
Tekka, Malay	2 15 0	3 5 0
Tronoh, Malay	1 5 0	1 10 0

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

EARLY HISTORY OF THE ELMORE FLOTATION PROCESS.

In the *Mining and Scientific Press* for September 23, A. Stanley Elmore gives a history of the development of the flotation process. The article is written expressly for the purpose of demonstrating the debt of the mining community to Frank Elmore for his invention of 1898. In these days when others are re-inventing the process and everybody is applying it, the early history of the pioneer work merits this recapitulation. This Magazine has always done full justice to the Elmores' work, so lengthy extracts from the article are not necessary. There is one point, however, which deserves quotation; that is how Frank Elmore came to interest himself with flotation. We give herewith Mr. Stanley Elmore's account, and in our Editorial columns we make comment.

Frank Elmore was, in the nineties, in control of metallurgical works at Leeds, producing copper tubes and sheets by means of the Elmore electro-depositing process. He was recognized as possessing that rare combination of an imaginative or inventive mind coupled with sound practical ability to design plant for applying on a commercial scale the product of his imagination. At this time William Elmore (father of Stanley and Frank) made a considerable investment with friends in a low-grade auriferous copper mine at Glasdir, Wales. In due time a plant, consisting of the usual jigs, shaking tables, etc., was erected, but it proved, after the expenditure of much time and money, to yield so low an extraction of values as to result in financial loss. The brothers were asked to investigate and see if the extraction could be improved. On the occasion of one of their visits to the mill it was observed that at the angle where one of the launders carrying the water-borne pulp deflected the stream, some splashing took place, and it so happened also that oil had dripped on to the outside of the launder at this point from a shaft-bearing immediately overhead; a strong sun was shining upon it and a glittering reflection attracted the eye. On examination it was noted with interest that, adhering to the oil, was a coating of what appeared to be quite clean copper pyrite, and it was remarked that no rock seemed to adhere to the oily surface. A little later a piece of ordinary 2 in. iron steam pipe, which was in such a position that the discharge from one of the slime launders splashed against it, was found to have a clear picture of a man's hand printed on it in bright copper pyrite. It had been carried in a greasy hand, and the whole of that part of the surface which had received a very thin coating of grease by contact with the hand subsequently became coated with pyrite. It was these two accidental observations which led to the invention of the flotation process. These were the source of Frank Elmore's inspiration. At that time he had no knowledge of the virgins of Herodotus, nor of Haynes, Everson, or Robson and Crowder. The fact was shown that finely divided wet copper pyrite would adhere to a greasy surface, whereas finely divided wet rock would not. A means of separation was here indicated; experiments were immediately undertaken, on a small scale at first, gradually increasing in importance as encouragement was obtained. The result of this work was the filing of Frank Elmore's patent of 1898. The process there described was applied on a practical scale at the mine referred to; one full size working unit was first installed and others later.

OIL SHALES IN NORFOLK.

In our issue of March last we quoted from a paper by W. H. Manfield describing the Kimmeridge oil-bearing shales of the Oolite in Dorset. Mr. Manfield traced the history of the attempts to extract usable oil from these shales, and he mentioned the high sulphur content as the stumbling-block in the road to success. He also showed that these shales extend northeastward along the Jurassic outcrop to Norfolk, Lincoln, and the East Riding of Yorkshire. At the meeting of the Institution of Petroleum Technologists held on October 17, W. Forbes-Leslie described the work done in Norfolk during the last two years for the purpose of proving the existence of the oil-shales and demonstrating their value. The author gives credit to John Wells for much of the work that has been done. The author describes at some length the Wormegay oil-shale basin south of King's Lynn and its geology. The Great Ouse river flows along one of the gentle folds in the underlying Jurassic rocks. These rocks are mostly overlain by glacial debris, which also fills the ancient Jurassic valleys. Here and there subsequent erosion has laid bare the oil-bearing shales. It is possible to distinguish two types of oil shales in the upper horizons of the Kimmeridge clays on the northern section of the Ouse valley outcrop. The upper series, known as Smith's, after the name of a farm, consists of dark brown shale of bituminous appearance, included in dark blue clays and capped by limestone. Toward the base of the series is yellow sandstone containing bitumen between the bedding planes. Below this sandstone comes the lower series, called the Puny Drain series. These shales are more open in texture than the upper shales. They are bluish in colour and they contain more marine fossils and fish remains than the upper series. Smith's shales vary in thickness from 100 ft. to 300 ft. Two rich oil seams have so far been discovered, one under the limestone capping, and the other over the dividing sandstone. The latter seam is 6 ft. thick and yields on distillation up to 50 gallons of oil to the ton. The Puny Drain series is from 200 to 500 ft. thick. One oil seam has been proved 7 ft. thick, and yielding up to 51 gallons of oil per ton. This seam outcrops on Puny Drain to the south of King's Lynn. The shale when broken exudes free oil, especially when subjected to the action of running water.

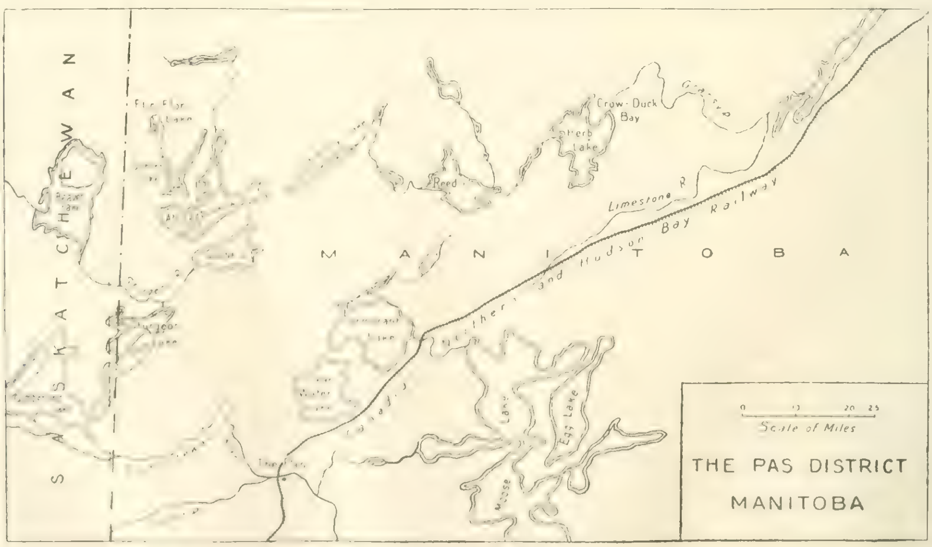
Distillation of the shales of the two series shows a fairly even composition as follows: Moisture, 8 to 10%; volatile organic matter, 31 to 35%; fixed carbon, 15 to 16%; ash, 40 to 46%. The sulphur content of the shale varies in the analyses from 4·32 to 7·8%. Some of the sulphur is contained in pyrite and the rest is in the organic compounds. The oil obtained by distillation is golden black in colour, with a purplish tint on reflected light. It is very fluid, running almost like water, though its specific gravity is as high as 0·95. A test on a commercial basis gave 40 gallons of oil per ton, 1% of nitrogen equal to 66 lb. of sulphate of ammonia, and 25,000 cubic feet of illuminating gas. Fractionation gave: up to 100°C., 3·8%; 100° to 170°C., 5·7%; 170° to 245°C., 19·2%; 245° to 310°C., 39·2%; water, 0·8%; pitch and loss, 31·5%. The yield of fractions coming within the limits of motor spirit is notable. It will be seen from the above figures that the sulphur content is the only drawback. It is stated, however, that in the laboratory this content can be reduced to below 3%, the present Admiralty limit, so that the prospects for commercial utilization of these deposits are far from discouraging. Experiments to reduce the sulphur content are in hand.

THE PAS GOLD DISTRICT, CANADA.

In recent issues we have quoted extensively from Canadian publications with regard to new discoveries of gold in Ontario and Manitoba. In addition to those already described, the region north of The Pas, in Manitoba, near the boundary of Saskatchewan, has attracted considerable attention lately. The Pas is a station on the Canadian Northern and Hudson Bay railway, where it crosses the Saskatchewan river. About 50 miles north by west of this station, sulphide-gold ore has been found at the Flin-Flon and Schist Lakes, and farther east similar deposits have been found at Herb Lake. In the *Canadian Mining Journal* for September 1, J. S. De Lury gives an account of this district, and we quote from him herewith. The Canadian Geological Survey has also published memoirs on the district by W. McInnes and E. L. Bruce. As in other regions in Ontario and Northern Canada, isolated patches of Keewatin-Huronian rocks are found, surrounded and underlain by Laurentian and other granitic intrusions. These patches are the remnants of deposits which were mostly eroded in the glacial epoch. Probably all of these rocks were covered originally by Paleozoic limestone, which no doubt formed a protective covering for the Keewatin-Huronian rocks. The ores of the area are mostly sulphide replacements or quartz veins in schistose rocks, the ores and veins being generally parallel to the schistosity of the rocks. Many of the rocks, even when not close to known orebodies, show a considerable sulphide mineralization. Some of the schists are of sedimentary origin, including sericitic, staurolitic, and garnetiferous varieties. Others are of igneous origin, felsitic and porphyritic, and to others it is difficult to ascribe a definite origin.

Of all the deposits worked so far, the most interesting are those at Flin-Flon and Schist Lakes. Both of these deposits are of the sulphide type. They are on the shore near lake level, and the limit of what could be shown by surface work was soon reached. During the past season, two American companies have been investigating these properties by means of diamond drills.

On Flin-Flon Lake trenching and diamond-drilling have been done on two claims, the Apex and Unique. The ore consists of partly replaced schist grading into bands of sulphides, of which pyrite, chalcopyrite, and zinc blende are the more abundant, with galena and arsenopyrite in small quantity. There has been oxidation on the surface, and the mixture of rock and sulphides weathers more readily than the massive sulphide bodies. Gold is found in the sulphides. Free gold has been found in some of the drill cores, and the oxidized material yields gold in the pan. The orebody is obviously a replacement deposit,



and as in most replacements, the ore is irregularly distributed throughout a wide mineralized zone. The banded nature of the ores can be ascribed to changes in the ore-bearing solutions and successive replacements of layers of the fractured rock zone. In places on the weathered surface of the orebody, the mineralized rock has been entirely leached of its sulphides, and there is left a bleached pumice-like mass of rock. The irregularity of the orebody makes it impossible to give tangible dimensions. The replacement zone has in one place a width of 200 ft., and indications of ore are found throughout a length of 2000 ft. Wide bands of solid and mixed sulphides are found in most of the trenches, and these are always accompanied by rock rich in sulphides. Drills have cut the orebody at several depths up to 500 ft., but no authentic information could be obtained as to the size or nature of the body at these depths. The schist carrying the ore appears to have been a rather basic felsite. There are several varieties of rock in the vicinity, including schistose gabbro and quartz-porphyry and a fresh-looking granite dike which grades into quartz-porphyry on the edges. No connection of any of these rocks with the origin of the ores was established. The ore-bearing schist strikes a little west of north and is nearly vertical, having a dip of about 80° east. The ore appears to follow the strike and dip of the enclosing rock.

On Schist Lake is a sulphide orebody that is similar to that on Flin-Flon Lake. Trenching has disclosed a wide mass of pure chalcopyrite with accompanying bands of pyrite and zinc blende and mixtures of these. Surface weathering, as at Flin-Flon, has resulted in the formation of iron capping on the upper few feet of the ore, and noticeable deposits of covellite and chalcanthite were formed. The nature of some of the partly replaced rock indicates that the ore was deposited in a zone which, beside being schistose, was also fractured. The ore zone is not as large as at Flin-Flon, being, as far as has been determined, confined to a surface area less than 500 ft. long and 80 ft. wide, but in this are some large bodies of valuable sulphides. Drilling to depths up to 500 ft. shows that there is an extensive orebody and that it is of the pockety nature of replacement deposits. The orebody, following the rock, has a dip of about 75° east and strikes a little west of north.

Both of these sulphide bodies appear to be large enough and rich enough to warrant the expectation that at some time they will be important producers. There are excellent chances for finding similar bodies along the same zone of fracture, and for that matter, elsewhere in the district. Similar sulphides have been reported from the Pineroot country to the north and east of these deposits, and also on Arthapapuskow Lake. On Sandy Lake is an impregnation of pyrite and possibly other sulphides in a graphitic schist, but the value of this is not known.

The country on the east side of Herb Lake has furnished promising gold prospects. In this area are found gold-bearing quartz veins which occur in a sericitic schist and in a schistose diorite or gabbro. With the quartz are notable amounts of tourmaline and a little carbonate gangue. Besides free gold, the veins carry sulphides which are largely arsenopyrite with some pyrite, chalcopyrite, zinc blende, and galena. Mineralization is fairly constant throughout the length of the veins, but apparently less in proportion to the width in the wider parts. Free gold is fairly persistent, and in places it is rich. Arsenopyrite is scattered in grains throughout the country rock adjacent to the veins. The veins run between a north-south and a northeast-southwest direction, and are nearly vertical, following both the strike and dip of the country rock. They are irregular in width, thinning to a few inches in one place and widening to lenses up to 6 or 8 ft. in another, while they seem to be fairly persistent in length wherever they have been stripped or cross-trenched. Some of them have been traced in these ways for several hundred feet.

On Crow-Duck Bay, across from the gold deposits above described, is a quartz vein which has been exposed for a short distance. It contains molybdenite, also orthoclase and tourmaline crystals, and a little pyrite and chalcopyrite. It is said to carry small amounts of gold. The vein is small and has not been traced for any great distance. The country rock is a quartz-diorite or quartz-monzonite with a gneissoid structure

On the whole, the discoveries of gold in this region are remarkable for their number and nature, considering its brief history. Mr. De Lury feels justified in predicting a bright future for further prospecting and development.

SHAFT-SINKING UNDER THE SEA.

The *Colliery Guardian* for September 15 contains an article describing the sinking of two colliery shafts 100 ft. apart at Boness, west of Edinburgh, for the Carriden Coal Company. Boness is on the south side of the Firth of Forth, under which the coal seams pass. These two shafts were sunk in the sea, below low-water mark, in order to gain access to the continuation of the seams. The sea bottom here consists of 14 ft. of mud, below which is loose sand, then a layer of hard flag-stones. Underneath comes sandy clay, and then about 60 ft. of solid, hard, stiff boulder clay. At about 120 ft. from surface, the Carboniferous strata are reached. The clay beds form an effective protection against sea-water entering the coal workings below. Nor does the water give any trouble during sinking. The difficulties of sinking arose from the nature of the strata which caused breakages of the iron tubbing, and deviations from circular form and vertical line. Coffer-dams were first built around the points where the shafts were to be sunk, not so much to keep the sea out, as to ensure still water, and also to form the platform from which the work was to be done. Sinking was done by the caisson method, in which the built-up iron tube with sharp cutting edge at the bottom is forced down through the strata by its own weight, and the ground removed by grab-excavator. No filling between the tubbing and the strata was necessary, as the clay pressed firmly on the outside of the tubbing. The shafts were eventually brick-lined.

No. 1 shaft was designed to be 12 ft. inside diameter within brickwork which would be 18 in. thick. The iron caisson was designed to be 15 ft. 4 in. outside diameter and 14 ft. 3 in. inside diameter. The thickness of the metal in the tubbing was 2 in., except at lower part of the bottom ring where it was $2\frac{1}{4}$ in. This widening was arranged so as to reduce skin friction in sinking. Each ring of tubbing consisted of eight plates, and weighed 11.7 tons without bolts. A start was made with 25 ft. of tubbing hung from the frame on the coffer-dam. The bottom of this tubbing reached the mud. Four more rings were then added, and excavation of the mud was then begun. The tubbing began to sink by its own weight too fast, but fortunately the top did not go below water-level. When the tubbing came to the stratum of hard flagstones, sinking was arrested, in spite of all the available segments being built on the top. It became necessary, therefore, to break the flagstones by blasting. All went well after that, until, at a depth of 93 ft., while the cutting edge was in strong clay, the ring above the bottom ring began to crack and buckle. This action gradually extended to the bottom ring and to the third ring, and the cross section of the shaft assumed a pear shape. It was decided then to make the remaining part of the shaft to be sunk narrower, and new tubbing was constructed to make a tube 12 ft. 6 in. outside and 11 ft. 6 in. inside diameter. In order to support the shaft, square frames were put in every 2½ ft. for six rings up. Meanwhile, the building of the brick lining was commenced above the frames. The narrower tubbing was built up at the bottom of the shaft inside the first tubbing. An attempt was made to force it down by hydraulic jacks working against the bottom of the brick lining, but this was ineffective, and sinking was continued afterward on the same lines as before. Eventually the shaft met the Carboniferous series, and the usual brick-lining was then put in. The shaft is about 15 inches out of the vertical.

No. 2 shaft was commenced subsequently, at a point 100 ft. west of No. 1 shaft. This shaft is wider than No. 1 shaft, the outside diameter of the tubbing being 19 ft., and the inside diameter 16 ft. 3 in. Experience with No. 1 shaft showed that it was advisable to build the brickwork as the tubbing sinks. The thickness of the brickwork at this shaft was 14 in. The weight of the brickwork aided in the sinking of the tubbing. The tubbing was of a more substantial construction, the thickness of the plates being 2½ in., as compared with 2 in. at No. 1 shaft, and the quality of the iron was much improved. The sinking of the tubbing was kept farther in advance of the excavation than was the case with No. 1 shaft, so as to avoid the buckling then experienced. No attempt was made to keep the shaft dry during sinking, and water was allowed to come in, with the object of keeping the pressure inside and outside of the shaft equal. The sinking of this shaft provided other anxieties for the engineers, for the tubbing deviated no less than 11 ft. in 125 ft. In order to bring it back to nearer the vertical, a number of bore-holes, about 40 altogether, varying in depth from 10 to 90 ft., were sunk behind the shaft on the side toward which it was to be moved. Water under high pressure was pumped down these bores so as to soften and disintegrate the clay. At the same time, extra weight was added to this side of the tubbing, and eventually the tubbing was gradually drawn back, so that the centre line was only 18 in. out of vertical. This righting of the tubbing occupied a great deal of time, and postponed the completion of the shaft. The tubbing was continued to the first coal-seam, where a brick wall was built 5 ft. thick all round the bottom of the shaft. Both the No. 1 and No. 2 shafts were continued below the horizons of the Carboniferous strata by the usual methods. The main coal seam is at a depth of 450 ft.

QUEENSLAND SAPPHIRES.

Sapphires were discovered forty years ago in the Anakie district of Queensland, which is situated about 200 miles inland from Rockhampton and Mount Morgan. At first there was prejudice against them on account of the colours not being "orthodox," but eventually German buyers with a market in Russia came forward, and since then until the beginning of the war, mining has been conducted on a gradually increasing scale. The only set-back occurred during the Russo-Japanese war. During 1913 the value of the output was estimated at £43,292. At the present time the operations are greatly restricted. In the hopes of helping the Anakie industry, a paper on the subject has been written for the *Bulletin* of the Imperial Institute, and is published in the April-June issue, which, by the way, made its appearance in mid-September. We quote at some length from this paper.

As regards crystalline form, the hexagonal pyramid is common, but the prism is comparatively rare. The usual rhombohedral form also occurs, and crystals are frequently terminated by a basal plane. Basal and rhombohedral partings frequently occur, and in consequence of these, basal "cleavage" plates, showing the familiar triangular striations on the base, are not uncommon. In some instances the basal parting planes are so fine that they give a moonstone-effect in the polished stone. Stones of the star-sapphire type, showing the phenomenon of asterism, also occur. The hardness is stated to be variable. Lapidaries find in cutting the stones that some portions are more difficult to cut than others, and they have repeatedly stated that in some specimens the hardness is greater than 9, which is the degree of hardness of typical corundum. The specific gravity of many specimens which have been examined has varied from about 4 to 4·05. The colour is variable, and the following eight varieties have been observed: sapphire (blue), "oriental amethyst" (purple), "oriental ruby" (red), "oriental peridote" (green), "oriental chrysoberyl" (yellowish green) "oriental topaz" (yellow), "oriental cat's eye" (smoky), and "oriental moonstone" (pearly). The lustre of the clear stones is stated to be "almost adamantine," but in the coarser translucent varieties it may be opalescent, bronzy, milky, pearly, or silky. Opaque varieties are usually black, but sometimes also brownish-black, dark blue, light blue, and greyish white. In some of the stones foreign mineral matter has penetrated the parting planes, in some instances rendering the stone opaque. In other instances a blood-red colour may be seen along certain directions, due to the deposition of films of hematite. Magnetite occurs as inclusions in some specimens, sometimes in the form of microscopic crystals. In several specimens of deep green sapphire, magnetite was observed in dusty masses, and in one crushed specimen it was readily detected both with the blow-pipe and magnet.

The oldest and most widespread rocks of the district are granites, syenites, gneisses, schists, and slates. Pegmatite, porphyry, and felsite occur abundantly as intrusions traversing the granites and gneisses in all directions. Rhyolites and intrusive diorites also occur. Slates predominate in the eastern portion of the district. In some places the slates dip vertically and are disturbed by diorite intrusions. There is a conspicuous break in succession between these older rocks and the next younger formation, the Drummond beds. The latter consist chiefly of shales, sandstones, and congolmerates. They are of doubtful age, but possibly Permo-Carboniferous. No Mesozoic beds are found in situ; but there occur in the surface alluvial deposits certain boulders of rock that may have been derived from younger beds which formerly existed in this area, but which have been removed by denudation. These boulders are known locally as "billy," they consist of hard flinty quartzite, and are of frequent occurrence in the alluvial deposits of Central Queensland. Their exact origin is doubtful. They have been regarded as remnants of a Mesozoic formation, but it has also been suggested that they have been formed by the cementation of sand underlying the basalt. The youngest formations of the district are alluvial deposits and flows of basalt. The alluvium partly underlies and partly covers the basalt. Peaks of basalt occur in many places, but no extensive sheets of it are known at present. It is suspected, however, that basalts formerly covered a large area in the district, and that some have been largely removed by denudation. Some of the basaltic peaks reach a considerable altitude, and heights of 2000 ft. or more above sea-level are recorded.

The study of the basalt has thrown some light on the problem of the origin of the sapphire. At Mount Hoy, spinel of the pleonaste variety was found to occur abundantly in the basalt, and the crystals had the appearance of being corroded. A specimen of pale-blue sapphire was found on the summit of Mount Hoy, at a height of 500 ft. above the highest of the sapphire-bearing alluvial deposits, and it is considered probable that the sapphire, like the pleonaste associated with it, was weathered out of the basalt. At Mount Leura, one of the loftiest of the basalt peaks, a piece of bronze-black corundum was found embedded in the basalt. Other minerals enclosed in the basalt at Mount Leura are pleonaste, ilmenite, hornblende, olivine, plagioclase, and quartz, all of which show corrosion effects. From the summit of Black Peak, the highest of the basalt peaks, pleonaste, ilmenite, hornblende, and corundum were obtained. An interesting occurrence of basalt is that at Policeman Knob, where an old alluvial deposit lying on mica schist is covered by a sheet of basalt. Here zircons are numerous in the alluvial deposits underlying the basalt, but sapphire is not associated with them. This occurrence of zircon and absence of sapphire in the alluvium underlying the basalt, taken in conjunction with the proved occurrence of corundum in and on the basalt, leads to the conclusion that the sapphires have probably been derived from the basalt. Confirmatory evidence for this view is provided by the fact that basalt is associated with sapphire in the sapphire-bearing gravels.

There are four or five important sapphire-bearing alluvial deposits, and various others smaller and less important. The chief deposits are those in the Central, Tomahawk, Boot and Kettle, Policeman, and Retreat creeks. Of these only the deposits on the Policeman and Retreat creeks were being worked recently. It was on the Retreat creek that sapphire was originally discovered. The thickness of the sapphire-bearing alluvium varies considerably in different parts of the district. In some places it is only a few inches thick, in others several feet. At the base of it there is frequently a layer of reddish clay resting on decomposed schists and slates. In some instances, however, sapphire-bearing gravel underlies this layer of reddish clay. The gravel is in some places very clayey; in other places it is practically free from clay, and can be more readily sifted and worked. The sapphire is not distributed uniformly through the gravel; in some instances small patches only are found to be sapphire-bearing, and these are surrounded by large quantities of barren gravel. In other instances there is a nearer approach to uniformity of distribution, the sapphire occurring more generally throughout large masses of gravel. The colour of the gravel, where it rests on a foundation of the older rocks, varies with the nature of the rock. It has been observed that the gravel tends to a reddish colour where it rests on schists and slates, and to yellowish on granite, while it is almost black where it rests on basalt or other basic igneous rocks. The mineral composition of the gravel does not vary much in different parts of the district, the most noteworthy difference being that "billy" is abundant in the gravels of Retreat creek and other creeks trending eastward, whereas it is absent in most of the deposits on Tomahawk creek and other creeks trending northward. Minerals other than sapphire found in the sapphire-bearing gravels include spinel (spinel ruby and pleonaste varieties), garnet (pyrope variety), zircon, quartz (rock crystal, amethyst, and cairngorm varieties), chalcedony (carnelian variety), rutile, magnetite, ilmenite, tourmaline, hornblende, topaz, and diamond. Diamonds, however, are very scarce. A colourless, flawless crystal of diamond weighing 1¼ carats was found some years ago at Policeman creek; and two straw-coloured diamonds weighing about 1 carat each are reported to have been found in Retreat creek.

The mining of the Anakie sapphire deposits has been carried on by holders of small claims, and the methods adopted in obtaining and treating the gravel have been rather simple and perhaps lacking in efficiency. The methods of digging adopted are described as (1) "surfacing," or simply removing and treating the soil; (2) "deep surfacing," which necessitates the removal of several feet of overburden that may or may not carry sapphire; and (3) sinking shafts through the overburden into the sapphire-bearing gravel, the boulders and large pebbles of which are packed behind to prevent caving and to save unnecessary haulage. Where the gravel is coarse and the sapphires are of fairly large size, hand-raking is adopted and the gems are picked out. Otherwise, sieves are used to screen the material. One type is a small circular sieve swung from a tripod. Another type is a double screen, the upper sieve of which has a 1 in. or 1¼ in. mesh, whilst the lower sieve has a ⅛ in. mesh. Where the double screen is used the material that passes the upper sieve and is caught on the lower sieve is reserved for further treatment in a rotary machine, which may be driven by hand, horse, or engine. Oil engines have been introduced and used successfully for this purpose. The recently adopted practice of using rotary machines to sort the gravel has proved to be a substantial economy of labour. The rotary machine in use is described as a circular iron pan 5 ft. in diameter and 1 ft. deep, with a marginal feed and a central discharge. The wet gravel as fed in is stirred up by blades, set diagonally, each 10 in. long and 2 in. wide, attached to four arms driven from a central shaft making seven revolutions per minute. The gemstones and heavy minerals are thrown back toward the margin of the pan, and the slush escapes as waste at the centre of the pan. The concentration effected is in the ratio of about 50 to 1. The concentrate is then roughly classified by sifting and the sapphires picked out.

The yield of the gravel is variable. At the Scrub working, on the south side of Policeman creek, the average yield per load is given as ½ oz. of "parcel blues," ¼oz. "small blues," and 1½oz. "machine stone." "Parcel blues" are defined as those of medium size; "small blues" are mostly less than 1 carat in weight; "machine stones" are defective in colour and are up to ½ oz. in weight. At some workings "fancy" stones are sought chiefly, and the yield of stones of this character is uncertain. Large blue stones and coarse corundum crystals are obtained in some places. Gravel yielding ½ oz. of "parcel blues" per load can generally be worked without loss, but if less than a foot of gravel has to be mined, a return of 1 oz. per load may be necessary for profitable working. In April 1913 the prices realized for stones were 5s. to £5 per dwt. for fancy stones; £2. 10s. to £6 per oz. for large blue stones; 35s. per oz. for parcel blues; 7s. 6d. per oz. for small blues; and 3s. to 3s. 6d. for machine stones. Pieces of opaque corundum over 1 oz. sold at 6s. to 8s. per oz. An inferior or flawed variety of stone sold as "schneid" at 1s. 6d. per lb.

Much of the corundum and sapphire found at Anakie has proved to be valuable for mechanical purposes, and when free from fracture, though it may be useless for ordinary gem purposes, can be made into small bearings and pivots for parts of machines running at high speeds. It is noteworthy that there has been a strong demand for dark violet-blue stones. These stones are so dark that they appear quite opaque in dull weather, and can only be identified on a cloudless day. In the larger sizes, up to 3 oz. in weight, stones of this colour sell for as much as £5 per oz., although they yield a black stone when cut locally, and it is suspected that the Germans have some method whereby they can modify the colour. It may be suggested that this is probably done by the simple method of heating the stone. Many minerals, such as, for instance, smoky zircon, have their colour modified and their transparency greatly increased after having been heated to redness; and a specimen of Anakie sapphire examined at the Imperial Institute showed a greatly increased transparency as the result of this treatment.

GOLD-DREDGING IN MONTANA.

California gold-dredging practice has been frequently described in the public prints, but little has been written about the corresponding developments in Montana. While the industry in the latter state is not so large, it has undergone an interesting evolution beginning in 1864. Hennen Jennings, who has since 1906 been consulting engineer for the Conrey Placer Co., the largest gold-dredging company in Montana, has filled a large gap in technical literature in furnishing a "History and Development of Gold Dredging in Montana," published as Bulletin 121 of the United States Bureau of Mines. The Conrey placers have a special interest for engineers, as they form part of the Gordon-MacKay bequest to Harvard University for the endowment of the scientific and technical departments. Work began on them in 1898, and after preliminary attempts to mine by other devices, dredging began in 1899. Since that date 37,000,000 cu. yd. has been dredged with an average yield of 16c. per yd. At first steam-driven dredges, delivering to sluices on a separate pontoon, were built. In the period June 1904 to July 1906, 2,412,643 cu. yd. was dredged by machines of this type with costs per yard as below:

OPERATING:		
Labour	$0.0270	
Salaries	0.0053	
Material	0.0039	
Fuel	0.0327	
Total		$0.0689
REPAIRS:		
Labour	0.0099	
Material	0.0240	
Shop	0.0020	
Riffles	0.0016	
Total		0.0375
MISCELLANEOUS	0.0015	
CHAIN DEPRECIATION	0.0133	
BOSTON EXPENSE, TAXES, ETC.	0.0103	
TOTAL		0.0251
GRAND TOTAL		$0.1315

It will be noted that with the individual small-unit, steam-driven dredge, the total cost is nearly double the direct operating expense. Search for better methods led to the adoption of large, electric-driven dredges with stackers, as in California practice, and discarding of the separate scow for sluices after the latter had been developed to a size and perfection attained nowhere else. In the course of the development a number of features were perfected which are peculiar to the Montana dredges, such as the aerial spud, and others were first tried here. Among the latter are the big buckets, one-piece buckets, circular manganese bushings for bucket-eyes, water-tight bearings for lower tumbler and ladder roller bearings, manganese baffle-plates for revolving screens, direct gear-connected motors for bucket-line drive, and 2200 volt motors. The progress in design and capacity is illustrated in the following comparative statistics of the first steam dredge "Maggie Gibson" and the latest electric, "Conrey No. 4."

	Maggie Gibson	Conrey No. 4.
Power	Steam	Electric
Date built	1896	1911
Type	Double lift, sluice	Single lift, table, stacker
Anchorage	Spud-lines	Spud
Average monthly yardage	27,000	300,000
Hull dimensions:		
Draft	5 ft. 3 in.	9 ft
Length	110 ft.	150 ft.
Width	35 ft.	58 ft.
Depth	7 ft. 6 in.	13 ft.
Pontoon dimensions:		
Length	30 ft.	
Width	24 ft.	
Depth	4 ft.	
Stacker dimensions:		
Length		130 ft.
Width of belt		4 ft.
Motor drive		Upper end
Tailing height		55 ft.
Dimensions of Spuds:	(Wood)	(Steel)
Length	30 ft.	80 ft.
Width	1½ ft.	4½ ft.
Thickness	4 ft.	3 ft.
Weight, pounds		88,000
Number	2	2
Horse power:		
Bucket chain	45	550
Trommel	5	100
Pumps	40	285
Winches	10	250
Miscellaneous	None	50
Total	100	1235
Ladder:		
Length, ft.	70	116
Type	Queen truss	Plate girder
Depth digging below water	29	55
Tumblers:		
Upper—		
Distance above deck	12 ft. 7 in.	35 ft. 6 in.
Weight, pounds	2000	16,000 to 25,300
Number of sides	5	6
Shaft diameter, in.	9	25
Lower—		
Weight, pounds	3000	18,000 to 19,800
Number of sides	6	6 to round
Shaft diameter, in.	6	15⅜
Bucket chain:		
Type	Open link	Close-connected
Drive	Sprocket	Gear
Weight, pounds	40,000	357,000 to 415,000
Capacity buckets, cu. ft.	5	16-17
Number	35	80
Weight, pounds	750	4468 to 5191
Pitch, in	26	40
Buckets dumped per min.	7	18-22
Type	2-web	2-web
Material	Steel	Manganese steel
Hood and base pieces	2	1

Links, weight, pounds	300	
Pitch, inches	26	
Number in chains	35	
Material	Steel	
Type	2-web	
Pins, diameter, in.	3	7-8
Weight, lb.	50	520-495
Material	Steel	Steel manganese
Type	Double lug	Single lug
Bushings	Half circle	Full circle
Material	Manganese	Manganese
Trommel, length, ft.	14	48½
Diameter, in.	48	98
Type	Straight cyl.	Straight cyl.
Drive	Sprocket	Gear-belt
Trommel plates:		
Thickness	⅝	1
Material	Steel	Steel manganese
Perforations	4 by 4 in.	½-¾ in.
Tables:		
Grade		12½%
Number		24
Width, in.		30
Length, ft.		11 29¾
Riffles, angles, in.		1¼
Pumps	2	3
Number	4-in. water	4, 14, &
Size and kind	12 in. gravel	16 in. water
Make	Morris	Worthington
Gal. per min.	4000	12,000
Main winch:		
Length	12 ft.	29 ft. 10 in.
Width	6 ft.	7 ft. 5 in.
Diameter drums, in.	16	24
Number drums	6	8
Tail sluices:		12½%
Grade		12
Length, ft.		17-44
Width, ft.		48
Riffles, angle, in.		1¼
Under currents:		
Grade		12½%
Number		12
Length, ft.		7½
Width, in.		34
Riffles, angles, in.		1¼
Perforated plates, holes, in.		¼
Lower flume:		
Grade	5%	
Riffles, wood, size, in.	2 by 4	
Length, ft.	103	
Width, in.	38	
Total gold-saving area, sq. ft.	320	3000

Dredge No. 4 began work in 1911, and when it was built the bucket line, trommel, and digging motor were all the largest and strongest in use. Even they proved inadequate and have been replaced by heavier construction. The record month's performance was 411,000 cu. yd., dug in May 1915 with 82% running time, digging depth 54 ft. and operating cost 2·66 c. per cu. yard. The Maggie Gibson required the services of 13 men as against 10 on No. 4. The total number of men employed is now 85, and the total cost of equipment $1,070,000. With the new dredges approximately 30% of the operating cost is chargeable to repairs. The machine shop cost $50,000 dollars and it is necessary to carry a stock of spares and materials amounting to $60,000 to $80,000. From September 1, 1906, to July 31, 1915, a total of 31,379,890 cu. yd. was dug by four electric driven dredges with an operating cost of 5·91 c. per yd., to which should be added indirect expenses of 1·05 c. making a total of 6·96, which includes all expenses except interest on loans and indebtedness. It is interesting to record that the whole enterprise has been privately financed and no shares were ever offered the public. In comparing these costs with those elsewhere, differences in conditions must be taken into account, including the severe winters of Montana, the isolated situation and the fact that yardage is computed by accurate surveys and not by counting buckets. It has been found that even with a factor derived from experience, the latter is an unsafe method.

Supplementing Mr. Jennings' paper, Charles Janin presents a brief general statement on "Placer Mining Methods and Operating Costs" with especial reference to methods other than dredging but including figures from dredges in various parts of the world. Even when the cost of general excavation is considered, Mr. Janin shows that gold dredgers, taking account of their peculiar problems, have no cause for chagrin. Mr. Janin's paper is a preliminary contribution from the general report he is preparing on gold dredging for the United States Bureau of Mines.

COKE IN NEW SOUTH WALES.

A pamphlet published by the New South Wales Geological Survey, written by L. F. Harper and J. C. H. Mingaye, gives an account of the coke industry of that State. The chief feature of the practice is the disinclination of the users to favour the coke produced in by-product coke ovens. The only modern installation at present in operation, one built on the Semet-Solvay system, was erected for the Broken Hill Proprietary Company's steel works. The Broken Hill lead smelters and the Mount Lyell company make their coke on the older system.

The first coke ovens in New South Wales were erected about 1861 at Minmi, but no accurate records were kept in those days, and exact figures are only available from 1890 onward. The Co-operative Colliery & Coke Works were founded in 1875 at Wallsend near Newcastle, using coal from the famous Borehole seam, and the company is still an active producer. A year or so later, the Purified Coal & Coke Co. established a works in the same district, and is at present the largest individual producer in the State. Coking was commenced in the southern, or Illawarra, district in 1878, and among the most interesting ventures are those of the Broken Hill Associated Smelters at Bellambi and of the Mount Lyell company at Port Kembla. At the time the report was made, July 1916, there were four coke companies in the northern district, nine in the southern district, and two in the western district, having an aggregate capacity of 952 ovens. There are three chief seams in New South Wales that yield good coking coal. The first is the Borehole seam, already mentioned, in the Newcastle or northern district, and the second is the Bulli seam in the Illawarra, or southern, district. The third consists of restricted areas in the Lithgow seam in the western coalfield, 100 miles west of Sydney. An approximate composition of Borehole seam coal is: 56 to 60% fixed carbon, 36% volatile hydrocarbons, 5 to 6% ash, and 0·5% sulphur. At the Bulli seam, an average composition of the coal is: 60 to 63% fixed carbon, 24·5 to 26·5% volatile hydrocarbons, 11·5 to 12·5% ash, and 0·4 to 0·65% sulphur.

As regards the ovens used, the bee-hive was orginally employed, and some are still in use. Most of the later ovens are of the rectangular type. The coke produced in these seems more acceptable to customers than that produced in by-product ovens. Of the latter, the only installation at present producing is at the Broken Hill iron and steel works at Port Waratah, near Newcastle. The coke for the Broken Hill Associated Smelters at Port Pirie, made at Bellambi, near Port Kembla, is produced in ovens of the rectangular type. At one time the Port Pirie works objected to New South Wales coke on account of its high ash content, and bought English coke in preference, but at present the Bellambi coke contains 16% ash, so that the objection has apparently been overcome. As regards preliminary washing of the coal to remove mineral matter, only two companies do this, namely, the Mount Lyell and the Purified Coal & Coke Co.

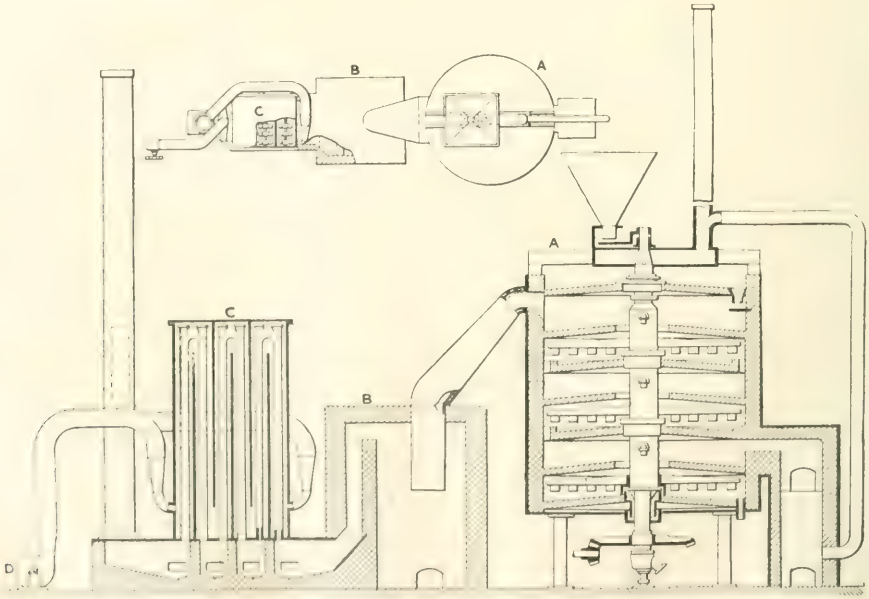
The Mount Lyell coke works was established at Port Kembla in 1899. The coal comes from the Mount Kembla colliery, 4 miles away. It averages 60% fixed carbon, 22% volatile hydrocarbons, 16% ash, and 0·2 to 0·3% sulphur. It is sent to washing plant where part of the clay-shale and calc-spar is removed. The coal as delivered to the coke ovens averages 23·5% volatile matter, 63·6% carbon, and 12% ash. The coke produced averages 82% carbon and 16% ash. The coal used at the Bellambi works of the Broken Hill Associated Smelters averages 64 to 66% carbon, 25% volatile matter, and only 9% ash, so that no washing is necessary. The coke is of much the same character as that produced by the Mount Lyell company.

In only one case are the by-products recovered, and with one other exception, where they are burnt for steam-raising purposes, the gases are allowed to go to waste. It is clear, therefore, that New South Wales coking practice is out of date.

METALLURGY OF QUICKSILVER.

In the *Engineering and Mining Journal* for October 7, W. H. Landers, chief engineer to the New Almaden Quicksilver company, California, discusses many points in connection with the extraction of quicksilver from its ores. Among other things he mentions the recent erection of continuous furnaces for treating ore that contains sufficient other sulphides to provide part of the heat required in roasting. The ore is roasted in a Herreshoff multiple-hearth furnace *A*. The dust is settled in *B*, and the quicksilver is condensed in *C*, the latter being cooled by air drawn through the fan *D*. The following is Mr. Landers' statement of details:

Circulating air passes through and cools the shaft and arms of the furnace, and is discharged into the stack, from which it may be diverted through the return pipe, in a heated condition, to the furnace grate for the combustion of fuel and the oxidation of the ore, the furnace grate communicating through a flue with the lower roasting hearth of the furnace. The air and products of combustion pass through the flue into the furnace and over the hearth in a direction opposite to the flow of ore, going to the vapour and gas outlets. The settler is made of brick or concrete or any material that will sufficiently conserve the heat, and for a similar purpose, the vapour and gas outlet flue from the furnace is best covered with heat-insulating material. The dust settler has two objects: first, to keep the vapours and gases sufficiently hot to prevent any precipitation or condensation of the quicksilver in the settler; second, by its large dimensions compared to the inlet, to reduce the velocity of the vapours and gases, allowing the dust to separate and settle more effectively. The condenser comprises a number of collecting chambers, or trays, in a base, successively connected by a number of standpipes, the last chamber communicating with the stack. Between and around the standpipe are baffles which form the space for the circulating cooling medium. This medium is supplied by the fan, which connects by a pipe with the baffle space, and this space communicates at the outlet end of the complete path of circulation with a pipe that is carried to and enters the stack. The air serves the double purpose of a cooling medium for the condenser and, in its heated condition, due to the interchange of heat in the performance of its first function, it



Diagrammatic Section of Landers' Quicksilver Furnace.

serves the further purpose of increasing the draft and creates a suction in the entire system, inducing a current of vapours and gases away from the furnace, thus taking them away from the roasting ore.

The ore in crushed condition, say from ⅜ in. mesh down, is roasted in the multiple-hearth furnace. The gases are then driven off, together with dust from the furnace, passing over into the dust settler. Here the gases will remain hot enough to prevent precipitation of quicksilver, but the current will be slow enough to provide for the settling of all the dust. The gases then pass into and through the condenser, and the quicksilver settles in the collecting boxes. The condensation is due to the current of air from the fan passing through the baffle spaces of the condenser. This quickly cools the pipe, and the gas, when liberated, is still heated aud is discharged into the stack, thereby increasing the draft and creating effective suction throughout the apparatus. Mr. Landers says that this type of plant is still in an experimental stage; no doubt, later on, he will give details of the results obtained and of the nature of the ore treated.

Graphite in Scotland.—In No. 5 of the Special Reports on the Mineral Resources of Great Britain, published by the Geological Survey, reference is made to the occurrence of graphite in Scotland. Graphite occurs in several localities in Scotland, and formerly was worked on a small scale at a number of mines. Whether any of the deposits could be worked by modern methods would require investigation.

Among the rocks of the Scottish Highlands, graphite-schists have a fairly wide distribution, especially in Banffshire, Aberdeenshire, and Perthshire. They are soft, dark grey, slaty-looking rocks, often fissile, and when handled they stain the fingers. The graphite occurs in minute dark scales, mixed with mica and quartz, and forms only a small percentage of the rock. Graphite-schists are found also at Loch Maree in Ross-shire, and in Inverness-shire. Occasionally graphite is visible as small bright grey scales in crystalline limestone, gneiss, and granite. Of the localities in the Highlands where graphite has been mined, one of the most important is in Strath Farrar. The old mine is situated on the north side of the River Farrar. The vein is nearly vertical and runs in a northeast direction. Its thickness is very irregular. At Invergarry, near the head of Loch Lochy, and about one mile from the Caledonian Canal, there is a vein of graphite said to be from 1 to 3 ft. wide. The graphite is of fairly good quality. This locality is not difficult of access, and it is possible that the vein would prove worth working. Near Huntly, graphite occurs at the old mines immediately below the bridge over the Deveron, on its south bank, and at its junction with the Bogie. Near the farm of Bodibae, in the Cabrach, Aberdeenshire, there is a vein of soft graphite several inches thick, and at the head of the Carvie Water there is a band of black schist included in diorite; it contains veins of graphite one to four inches thick.

Where beds of coal have been penetrated by an intrusive igneous rock they are often greatly altered, In some places they are changed to a spongy mass resembling coke; in others they are converted into anthracite; but the extreme form of alteration seems to be the production of graphite at the expense of the coal. Bores recently put down in the Manor Powis coalfield, near Stirling, passed through several seams of coal that had been altered in various degrees by the Abbey Craig dolerite-sill which lies beneath them. In one instance a thin seam in contact with the dolerite was converted into graphite.

The Craigman mine, Ayrshire, appears to be the only place in Scotland where graphite has recently been mined for economic use. The late C. T. Clough, of the Scottish Geological Survey, recently visited this mine and prepared a report on it from which the following particulars are taken. The mine, locally called the Waud mine, lies between 7 and 8 miles S.S.W. from Cumnock railway station. The mine consists of a short day-level with some side roads. It was worked on a small scale for about 100 years prior to 1848, when it was abandoned for a long period. The graphite was carted to Keswick in Cumberland, to be used with the Borrowdale graphite. In 1908 the mine was re-opened, but soon abandoned again. The graphite occurs in pockets of varying size and shape in an intrusive sill of dolerite 10 or 12 ft. thick. A little within the mouth of the day-level the dolerite is seen overlying a seam of burnt columnar coal about 2 ft. thick, and presumably the pockets of graphite represent portions which have been torn off by the dolerite, and being entirely surrounded by it, have been more intensely heated. The larger pockets contain also some coke, but a thin layer of massive graphite generally lies close above the dolerite. Some of the holes from which the graphite was mined are more than a yard in length and breadth. From one pocket as much as 15 tons of graphite was obtained, and at one end of it graphite is still visible. The pockets were irregular in size, shape, and distribution, and have been sought for by short side roads in various directions. One, which is still visible, is 4 or 5 ft. long in a vertical direction, and about 1 ft. wide. It is crossed by a nearly horizontal vein of dolerite 2 or 3 in. thick. The mine has been worked for a distance of about 66 yards in a northerly direction. Near the end a fault cuts out both dolerite and graphite. Analyses of the graphite differ greatly, the proportions of carbon ranging 97·3% down to 57·2%, possibly through the admixture of strings of dolerite. In 1908 the graphite was sold in Glasgow for iron-founders' requirements.

Molybdenite in New South Wales.—In our May issue we quoted from an article by E. C. Andrews describing the methods of concentrating molybdenite ores in New South Wales. Mr. Andrews is Geological Surveyor to the Mines Department of that State, and a bulletin written by him on the molybdenum industry of New South Wales is to be published shortly. A forward precis of the bulletin has been issued, and it is printed in the August issue of the *Mining and Engineering Review*, of Melbourne. The bulletin contains additional information relating to concentration processes, and we note that flotation plants have been adopted lately. On a future occasion we shall give details of these recent improvements. At present we confine our notice of Mr. Andrews' bulletin to the geological side of the subject.

All the molybdenite deposits of New South Wales are associated intimately with granites of varying ages. Certain types of these rocks appear to contain the great majority of the important molybdenite deposits; others contain small veins of quartz with molybdenite, the main ore being tin; others are associated with true white quartz veins; while others again have small flakes of molybdenite scattered irregularly throughout their mass. The general type includes the deposits of Kingsgate, Whipstick, Deepwater, and Bolivia. In hand specimens it is typically coarse, granular, non-porphyritic, sandy (silicious), and homogeneous. In the field it appears as areas relatively low in relief, the hills around, except at Kingsgate, being formed of more resistant rock types, such as tin and wolfram granites, quartz porphyry, or altered sediments. Unlike many other granitoid rocks in New South Wales, its intrusive junction with other rocks is very decided, and may be traced with ease by the geologist. There is also a freedom from the dense and scrubby plant growths so characteristic of the tin and wolfram granites in New South Wales. The second type of rock is wolfram granite, which is typically coarse, non-porphyritic, and very silicious, forming features of striking topographic relief, and being covered with scrubby plant growths. Tin granites are recognized in the field by their great topographic relief, their rugged, barren, and sandy nature, their complexity of shape, their peculiar mineral and rock association, and the dense scrubby nature of the vegetation. The fourth type includes basic granites ; molybdenite has been found in true quartz veins in dark hornblendic granites, but in every such case the basic granite is intimately associated with sandy or very silicious granites ; for instance at Moonbi and Bega.

The great majority of the important deposits of molybdenite in New South Wales consist of pipes. This does not imply that all large deposits of molybdenite occur as pipes. It simply implies that, up to the present time, the mining community has found no deposits of ore other than in pipes, from which considerable quantities of ore have been obtained possessing a degree of molybdenite concentration in nature sufficient to repay the expenses of mining and treatment. It is admitted by Mr. Andrews that the actual amount of molybdenite contained in the deposits of Yetholme, Booroolong, Glen Eden, Tantawanglo mountain, Laura creek, and other places is very great, but no mining operations at a profit have been conducted on such deposits, and, indeed, it would appear that they could be worked only at a profit by the employment of excessively cheap conditions, coupled with the greatest skill and economy. Pipes, in New South Wales, may be of many shapes, but, typically they have the appearance of tubes filled with quartz, granite, and allied material. Such tubes, however, are tortuous and irregular in general appearance. They occur within granite masses close to the intrusive contacts of the latter with other rock types, and although there is no general direction in which they dip, nevertheless in many cases they have a general direction which sympathizes with the intrusive contact surface of the granite.

The pipes consist mainly of quartz, pegmatite, silicified granite, or granite with much secondary mica or garnet. Their origin appears to have been due in great measure to the displacement action of heated vapours on the granite, but the complete evidence in support of this idea is reserved by Mr. Andrews for his full report. The main facts upon which this conclusion has been based are the lack of walls to the pipes, the interlocking of the ore with altered granite country, the "step-and-tread" appearance of many pipes, the arrangement of certain pipes along veins, the passage of certain veins into pipes, the peculiar mineral composition of many pipes, some of silicified granite with secondary mica, some with irregular patches of mica and garnet, some of silicified granite with a discontinuous core of quartz, some of brittle quartz surrounded by zones or collars of garnet or mica, some of solid quartz passing into solid granite.

As already mentioned the production of molybdenite in New South Wales has been principally from the pipes, and a careful search round the margins of the typical molybdenite granites of Kingsgate, Bolivia, Deepwater, and other places should result in fresh discoveries of importance. By reason of the relative softness of these granites, the harder or more resistant types of rock they have intruded tend to cover the pipe outcrops with debris, as at the Bolivia mine. The prospector needs to keep this in mind.

Mr. Andrews' account of New South Wales conditions may conveniently be read in conjunction with H. H. Claudet's description of molybdenite occurrences in Norway, published in our August issue.

The Miami Flotation Lawsuit.—As mentioned in our last issue, Minerals Separation won its case in the United States District Court for Delaware against the Miami Copper Company, the point involved being the infringement of the plaintiff's patent by the Callow process. The three United States patents belonging to Minerals Separation mentioned in the case were : No. 835,120 applied for May 29, 1905, and issued on November 6, 1906, to Sulman, Picard, and Ballot, and corresponding to the British patent 7803 applied for April 12, 1905 ; No. 962,678 issued June 28, 1910, to Sulman, Greenway, and Higgins, corresponding to British patent 2359 of 1909 ; and No. 1,099,699 issued June 9, 1914, to H. H. Greenway. In his decision Judge Bradford upheld claims 1 and 12 of the first patent, and the whole of the second patent, but declared invalid claim 9 of the first patent and the whole of the third patent. The wording of claims 1 and 12 of the first patent is as follows :

1. The herein-described process of concentrating ores which consists in mixing the powdered ore with water, adding a small proportion of an oily liquid having a preferential affinity for metalliferous matter (amounting to a fraction of 1% on the ore), agitating the mixture until the oil-coated mineral matter forms into a froth, and separating the froth from the remainder by flotation.

12. The process of concentrating powdered ore which consists in separating the minerals from gangue by coating the minerals with oil in water containing a fraction of 1% of oil on the ore, agitating the mixture to cause the oil-coated mineral to form a froth, and separating the froth from the remainder of the mixture.

Claim 9 reads as follows :

The process of concentrating powdered ores which consists in separating the mineral from the gangue by coating the mineral with oil in water containing a small quantity of oil, agitating the mixture to form a froth, and separating the froth.

The second patent describes the use of soluble frothing agents, and the third patent claims the use of an aromatic hydroxyl compound such as phenol or cresol in a neutral solution.

The decision may be taken to mean that Minerals Separation's claim for reducing the amount of oil to less than 1% holds good. This is in direct variance with the judgment of the Appeal Court in connection with the case of Minerals Separation versus J. M. Hyde, delivered two years ago, on which occasion the court held that the amount of oil had no bearing on the question, and that Minerals Separation were invalid. Arguments before the Supreme Court on the Hyde case are expected to commence this month. It will be interesting to see how the judges will reconcile these two outstanding judicial opinions. We take most of the above information from the *Mining and Scientific Press* for October 7, 14, and 21.

NEW BOOKS AND OTHER PUBLICATIONS

The Data of Geo-Chemistry. By F. W. Clarke. Being Bulletin 616 of the United States Geological Survey. Third edition. For sale at the Technical Bookshop of *The Mining Magazine*. Price 8s. 6d. net.

The first edition of this work appeared in 1908, and a second edition, revised and enlarged, was issued in 1911. The issue of a third edition, again revised and enlarged, affords eloquent testimony to the scientific value and growing popularity of this monumental treatise on geo-chemistry. There is perhaps no other single bulletin of the United States Geological Survey that is of wider or more profound interest to the student of geological phenomena than Mr. Clarke's work on this fascinating but in many respects difficult and obscure branch of scientific inquiry. For those geologists who are familiar with the earlier editions, it is unnecessary to summarize the contents here, as the present edition is framed on the same model as its predecessors. Doubtless many engineers are as yet unfamiliar with the work, and to such there is but one piece of sound advice, namely, obtain a copy and study it. Especially does this advice apply to those interested in the economic geology of mineral deposits.

One of the difficulties with which an author is beset in the construction of a treatise of this kind is the selection and co-ordination of the multifarious data scattered throughout a voluminous literature. Both in the art of selecting material and in its general presentation, Mr. Clarke has shown himself a past-master, and he has handled his subject in a felicitous and luminous manner. His critical discussions of the facts and deductions that have been made therefrom by the numerous authorities cited in the text, are conducted throughout in a broad and philosophic spirit such as eminently befits a work which is in fact, if not in name, a short dictionary of modern geo-chemistry. It is essentially a treatise for the practical worker in chemical geology, whether his special interest be in the field or in the laboratory, or in both. The excellent bibliographic treatment of the subjects discussed is a feature that greatly increases the practical utility of the main body of the work, as by its aid the relevant literature is shown at a glance. Geo-chemistry as a science is advancing by leaps and bounds, and the need for an encyclopædic dictionary of the subject comparable with, say, Watt's Dictionary of General Chemistry, is becoming more apparent as time goes on. Such a work would be of incalculable value in the economic development of the natural resources of mother earth in the period of peaceful progress to which we look forward when the warring nations shall have settled their angry disputes. There is but one serious criticism of Mr. Clarke's treatise, namely, that it is all too brief. One wishes that it might be made the nucleus of a much more comprehensive dictionary of geo-chemistry allied with its sister science geo-physics and produced under international auspices by a combination of the efforts of the principal geological surveys and leading authorities on geo-chemistry and geo-physics.

In some minor particulars a word of warning may be advisable in regard to the usage of certain terms. The question of molecular size is one that seems likely to be of considerable importance in connection with many of the problems that are presented to the geo-chemist. In the chapter devoted to rock-forming minerals molecular weights and molecular volumes are stated for many minerals in cases where these quantities are as yet not definitely known. For instance in the case of the three modifications of silica, quartz, tridymite and cristobalite, the molecular volumes are given as 22·8, 26·3, and 25·7 respectively, and the molecular weight is assumed to be the same for all three modifications. It is questionable whether this is an accurate representation of the molecular relationships of these different varieties of silica. Solid specific volume is a more suitable term for the figure obtained by dividing the simplest formula weight by the specific gravity. This figure may or may not be identical with the molecular volume of strict chemical terminology, and what applies to silica applies to many other minerals. The mineral arsenopyrite may be cited as another example of a somewhat similar kind. The common practice in American literature is to represent this mineral by the formula FeAsS, and other cases of a like nature could be cited. A comparative study of the specific gravities and other properties of the natural sulphides and arsenides of iron certainly does not support this view of the constitution of arsenopyrite, but points to the mineral being a mixture or loose compound of the lollingite molecule with the pyrite or marcasite molecule, possibly of the nature of a solid solution or alloy. The molecular volume of such a type of chemical system would obviously be much greater than would be the case if the unit system contains only one atom of each of the three elements, such as is implied by the formula FeAsS. The constitution of the element sulphur itself is of particular interest and significance, since the various sulphide minerals are the principal sources of supply of the heavy non-ferrous metals. It is well known that this element is not only highly associated at moderate temperatures and pressures, but that in the liquid state it is made up of more than one type of molecule. One misses from this volume the discussion of such matters as these, which are both highly suggestive and of importance in connection with scientific progress in the elucidation of the processes of ore deposition. The influence of porosity on the distribution of the sulphide minerals in ore deposits, suggestive as it is of processes akin to dialysis being involved in their differential deposition, renders the questions of molecular constitution and size of more than mere academic interest, and there is indeed in this connection a vast almost unexplored field for scientific research. It is desirable, therefore, if for no better reason, to keep the ideas of molecular volume and solid specific volume sharply defined and distinct, or there is a liability to provoke confusion of thought, as well as to obscure points of fundamental chemical and physical importance. In his discussions of the artificial syntheses of sundry minerals, the author seems to be a trifle biassed in favour of hydrochemical as against anhydrous methods of synthesis. That many of the artificial anhydrous methods that have been employed by experimenters do not even distantly reproduce conditions approached in nature is unquestionably true, but I am inclined to attach a somewhat greater value to anhydrous synthetic methods in the case of certain minerals than would appear to be credited to them in this work.

While some criticisms of this kind are permissible, they cannot detract from the general excellence aud immense scientific value of this unique treatise, which may be regarded as the standard work on geo-chemistry. Those who have occasion to consult it constantly will do well to provide their copy with a good stout cover as, the paper binding is scarcely strong enough for such rough wear as a reference work of this kind is often called upon to stand.

In conclusion, a review of this work would be seriously incomplete without an appreciation of the fact that the laborious and painstaking preparation of such a valuable treatise, coupled with the beneficent liberality with which it is issued to the public whether of the United States or other countries, is striking testimony to the broad and truly catholic scientific spirit in which the United States Geological Survey Department is conducted. Is it too much to hope that the Empire on which the sun never sets will ere long emerge from its comparative state of Egyptian darkness and emulate our transatlantic friends a little more in regard to the broad principles of policy to be pursued in the conduct of our Geological Surveys?

W. H. GOODCHILD.

The Metallurgy of Steel. Fifth Edition. By F. W. Harbord and J. W. Hall. Two volumes, with 54 folding plates and many other illustrations. Price 36s. net. London: Charles Griffin & Co. For sale at the Technical Bookshop of *The Mining Magazine*.

This text-book, one of Griffin's notable series, has for some years been accepted as the characteristic British expositor of steel metallurgy and manufacture. Its merits were suitably acknowledged by Sir William Beardmore, the president of the Iron and Steel Institute, when presenting Mr. Harbord with the Bessemer medal. When a fourth edition was published five years ago, the amount of matter added was so great as to make it necessary to split the book into two volumes. The fifth edition now appearing does not show the same rate of expansion, for there have been few important developments recently. New material has been inserted relating to methods for producing sound ingots and for decreasing segregation, and the production of chemically pure iron from phosphoric pig-iron in the basic open-hearth furnace. The chapters on the theory of hardening and on armour-plate manufacture have been largely rewritten. In connection with hardening, Professor H. C. H. Carpenter has contributed remarks on stress theories. In referring to this book, many metallurgists (including reviewers) make sole mention of Mr. Harbord's name, and omit to give credit to Mr. Hall for his share of the work. As a matter of fact, this section of the book is of unusual value, for it contains a vast amount of information about the treatment of steel, and its manufacture into commercial forms, that is not readily accessible elsewhere. He describes the mills employed in making rails, plates, angles, blooms, and billets, the application of the steam hammer and the press in forging, the manufacture of tubes and wires, the galvanizing and tinplate processes, and other allied subjects.

Centrifugal Pumps and Suction Dredges. By E. W. Sargeant. Cloth, octavo, 190 pages, with many illustrations. Price 10s. 6d. net. London: Charles Griffin & Co., Ltd. For sale at the Technical Bookshop of *The Mining Magazine*.

This is a book that will interest mining engineers in two distinct ways, one connected with the lifting of water from mines and the other with the raising of sand and gravel in suction-dredging. The author gives the theory of the action of various types of low and high lift pumps, and he describes their duty and power consumed. Several chapters are devoted to the method of manufacture of the pumps, particularly as it affects the design. The information he gives relating to pumps intended for raising solids is of value to the mining engineer contemplating dredging operations or the reclamation of old tailing discharged into a river or lake.

The Mineral Industry. Volume xxiv. Edited by G. A. Roush. Large octavo, 950 pages, illustrated, New York: McGraw-Hill Book Co. Price 42s. net. For sale at the Technical Bookshop of *The Mining Magazine*.

It is not necessary at this time of day to sing the praises of The Mineral Industry. The author of this short note assisted the late R. P. Rothwell in the preparation of the first volume, and subsequently did much to create a market for it outside the United States, so that he has been thoroughly familiar with the work and has recognized its great value to mining men. In the present volume we are glad to see as contributors many of the old guard: J. W. Richards, R. H. Richards, W. R. Ingalls, George F. Kunz, and others. One of the sections hitherto sometimes weak has been that devoted to tin; we are glad to see therefore that Baliol Scott, Editor of *The Mining Journal*, has undertaken the work this year. It is often difficult for an American editor to obtain first-hand information relating to happenings in other countries; in this volume the tin chapter is improved, but on the other hand the paragraphs with regard to gold in Australia and India are far from being representative.

Eclipse or Empire. By H. B. Grey and Samuel Turner. Paper boards, 316 pages. Price 2s. net. London: Nisbet & Co.

Like the Fat Boy in Pickwick, the authors wish to make our flesh creep. They show us all our faults at once and try to make us dissatisfied with our country and with life itself. They tell us of multitudinous inventions coming from other countries, and blame us for not having invented these things ourselves. But, on the one hand, they do not seek for the causes of this universal distribution of inventive genius, nor, on the other hand, do they suggest any remedy for Britain's alleged calamitous position. After reading the book we exclaim: How is it that Britain exists at all? But to quote the title of Henry Arthur Jones's latest play: We can't be as bad as all that.

Mine Gases and Ventilation. By J. T. Beard. Pocket size, leather binding, 210 pages, illustrated. Price 8s. 4d. net. New York and London: Hill Publishing Co. For sale at the Technical Bookshop of *The Mining Magazine*.

A reference book combining theory and practice in connection with coal mining.

An Introduction to Mine Surveying. By Thomas Bryson and G. M. Chambers. Cloth, octavo, 290 pages, illustrated. Price 5s. net. London: Edward Arnold. For sale at the Technical Bookshop of *The Mining Magazine*.

A book for surveyors and students of coal mining.

Russian Mines. Compiled by A. N. Jackman. Pamphlet, 50 pages, with map. Price 1s. net. London: *The Financial Times*. For sale at the Technical Bookshop of *The Mining Magazine*.

A useful reference book, giving particulars of the various British mining companies operating in Russia and Siberia.

Efficiency in First Aid. By Dr. N. Corbet Fletcher. Pocket size, paper covers, 200 pages. Price 1s. net. London: John Bale Sons & Danielsson Ld. For sale at the Technical Bookshop of *The Mining Magazine*.

The author is a well known writer on first aid and home nursing. This book is a manual of aids for senior students of first aid.

Coal and Coke. By F. H. Wagner. Cloth, octavo, 430 pages, illustrated. Price 16s. 8d. net. New York: McGraw Hill Book Co; London: Hill Publishing Co. For sale at the Technical Bookshop of *The Mining Magazine*.

Elements of Mining. By George J. Young. Cloth, octavo, 630 pages, illustrated. Price 21s. net. New York: McGraw-Hill Book Co; London: Hill Publishing Co. For sale at the Technical Bookshop of *The Mining Magazine*.

The Flotation Process. By Herbert A. Megraw. Cloth, octavo, 250 pages, illustrated. Price 10s. 6d. net. New York: McGraw-Hill Book Co.; London: Hill Publishing Co. Ld. For sale at the Technical Bookshop of *The Mining Magazine*.

The Coke Industry of New South Wales. By L. F. Harper and J. C. H. Mingaye. This is one of the publications of the New South Wales Geological Survey, and is sold at 2s. 6d. net. We give some extracts in our Mining Digest.

TECHNICAL PAPERS FOR THE MONTH

BRITISH.

Colliery Guardian.—*October 6:* Gas Detector for Miners' Electric Safety Lamps, T. J. Thomas. *October 13:* Treatment of Coal by Solvents to Ascertain its Nature, F. Fischer and W. Glud, from *Gluckauf*. *October 20:* Coaling at the Panama Canal, F. J. Warden Stevens; The F. L. Smidth Pulverizing Plant for drying and crushing coal; Pyrite and the Oxidation of Coal, T. J. Drakeley, paper read before the Chemical Society.

Engineer.—*October 6:* Marble-working Plant at Proctor, Vermont. *October 20:* Placing Concrete Lining in Tunnels by Compressed Air.

Engineering.—*October 6:* Losses in Zinc Smelting, H. Martin. *October 13:* Hydro-electric Power Stations on the Winnipeg River [continued October 20]. *October 20:* Peat Powder as Locomotive Fuel; High-Pressure Air-Compressors, J. M. Ford. *October 27:* Hydro-electric Machines for the Stora Kopparberg company, Sweden.

Institution of Civil Engineers.—*October 24:* Appliances for Handling Materials, especially at Ports, Sir J. P. Griffiths.

Iron and Coal Trades Review.—*October 6:* Robey Electrically-driven Air-Compressor at the Britannia Colliery, South Wales; The Lamborne Apparatus for Re-lighting Miners' Lamps. *October 13:* Officials' Reports to the Mine Manager, A. Varty, read before the National Association of Colliery Managers; Electrical Signalling in Collieries. *October 20:* Coal in Southern Manchuria; The Magnet Safety-Lamp Relighter; Steel Mine-Supports at Arley Colliery, Warwickshire; Robey's Grinder for Stone-dust employed at a South Wales Colliery. *October 27:* The National Coal Supply; A New System of Sparkless Signalling for Mines.

Manchester Geological and Mining Society.—*October 10:* The Structure of the Bristol and Somerset Coalfields, E. H. Staples.

Midland Institute of Mining, Civil, and Mechanical Engineers.—*October 5:* Widening a Shaft at Tinsley Park Colliery, Yorkshire, H. J. Atkinson.

COLONIAL.

Canadian Mining Institute Bulletin.—*October:* Experiments in the Production of Pine Oil for Flotation Purposes, conducted at the Buffalo mine, Cobalt; The Coal Trade of Nova Scotia in relation to Imperial Economics, F. W. Gray.

Canadian Mining Journal.—*September 15:* The Coal Dust Problem at Crow's Nest, B.C., W. Shaw; Mineral Resources of Newfoundland, R. W. Browne; Newfoundland Coal Deposits, J. W. McGrath; The Sullivan Lead Mine, East Kootenay, J. D. Galloway. *October 1:* Herb Lake Gold District, Manitoba, R. G. Wallace.

Chemical, Metallurgical, and Mining Society of South Africa Bulletin.—*August:* The Manganese Silver Problem, Walter Neal.

Geological Society of South Africa.—*September 11:* Notes on the Geology of Natal, E. H. L. Schwarz.

South African Mining Journal.—*August 26:* The Miners' Phthisis Report; Mines and Railways in Rhodesia, a memorandum issued by the mining industry [continued September 27]. *September 2:* Physical Culture and Miners' Phthisis, A. J. Beaven and W. H. Morgan. *September 9:* Clay Resources of Olifantsfontein. *September 16:* The Platkoppie Exploration Co. Floated; Progress of Tin Mining in the Union. *September 30:* The Cape Asbestos Industry; The Government Miners' Training School, report of the chairman.

FOREIGN.

American Institute of Mining Engineers Bulletin.—*October:* Manganese Ores of the Lafayette District, Minas Geraes, Brazil, J. T. Singewald and B. L. Miller; Recent Geologic Developments on the Mesabi Iron Range, Minnesota, J. F. Wolf; Geology of the Iron Ore Deposits of the Firmeza District, Cuba, Max Roesler; Rifling of Diamond-Drill Cores, H. M. Roberts.

Economic Geology.—*August-September:* Relations of the Chemical Compositon of Petroleum to its Genesis and Geologic Occurrence, C. F. Mabery; The Mineralization of Clifton-Morenci, Arizona, L. E. Reber; Laboratory Studies in Sulphide Ore Enrichment, S. W. Young and N. P. Moore; So-called Graphic Intergrowth of Bornite and Chalcocite, A. F. Rogers; Copper in the Red Beds of New Mexico, H. W. Turner.

Engineering and Mining Journal.—*September 30:* Lakeview Zinc Mine, Utah, D. W. Jessup; Discussion of Electrolytic Precipitation Methods for Cyanide Solutions, G. H. Clevenger; Mines in Junin Province, Peru, J. E. Singewald and B. L. Miller. *October 7:* Comments and Speculations on the Metallurgy of Zinc, W. R. Ingalls; Recent Changes in Smelting Practice at Anaconda, F. Laist; Quicksilver Metallurgy, W. H. Landers; Tuyere Connections for Copper and Lead Blast-Furnaces, R. H. Vail; The Donora Zinc Works, W. R. Ingalls; Blast-Furnace versus Reverberatory at Mount Morgan, B. Magnus; Lead-Smelting Practice in the United States, A. S. Dwight. *October 14:* Barrel Amalgamator, P. A. Robbins.

Journal of Geology.—*September-October:* Differentiation in Intercrustal Magma Basins, Alfred Harker.

Metallurgical and Chemical Engineering.—*October 1:* Can an American Potash Industry be Established?

E. D. Koepping; Thermal and Pressure Decomposition of a Naphthene Base Oil in the Gas Phase, G. Egloff, T. G. Twomey, and R. J. Moore; Twinned Crystals in Electrolytic Copper, H. S. Rawden; The Electrical Properties of Fibrox, an inorganic fibrous material with the chemical formula SiCO, E. F. Northrup: Electrolytic Recovery of Lead from Brine Leaches, C. E Sims and O. C. Ralston.

Mining and Engineering World.—*September 23:* Leadville Pumping and Drainage Projects, W. A. Scott. *September 30:* Electrolytic Extraction of Copper, W. A. Greenawalt. *October 7:* The Roosevelt Tunnel at Cripple Creek, W. A. Scott.

Mining and Scientific Press.—*September 16:* Atmospheric Decomposition of Cyanide Solutions, G. H. Clevenger and Harry Morgan; Agreement between Minerals Separation and the Inspiration, Anaconda, and other companies; Flotation Tribulations, J. A. Pearce. *September 23:* The Invention, Development, and Introduction of the Flotation Process, A. Stanley Elmore; Amortization and Depreciation, R. S. Lewis; Cupelling Losses in Assaying, H. T. Mann and C. Y. Clayton, abstracted from the Bulletin of the Missouri School of Mines. *September 30:* Editor's Interview with J. Parke Channing, giving details of his professional activities. *October 7:* Concreting the Sacramento Shaft at the Copper Queen Mine, Arizona; Flotation Concentration of Carbonate Ore, J. T. Terry. *October 14:* Text of the Judgment in the Case of Minerals Separation versus Miami [continued October 21]; Re-timbering a 4-Compartment Shaft at Cananea, H. J. Thiele.

YEARLY REPORTS OF MINING COMPANIES

Kamunting Tin Dredging.—This company was formed in London in 1913 to acquire an alluvial tin property at Kamunting, three miles from Taiping, in the Larut district of Perak, Federated Malay States. The company was promoted by F. M. S. Timah, Limited, which has also sold properties to the Chenderiang and Kampong Kamunting companies. M. T. N. Bluck is consulting engineer, and R. L. Naish is manager. A bucket-dredge, built by Fraser & Chalmers, started work in March 1915. The report for the year ended June 30 last shows that 1,150,000 cu. yd. of gravel was treated, and 621 tons of tin concentrate recovered, being a yield of 1·21 lb. per yard. The concentrate sold for £59,257, making the yield per yard worth 12s. 3d. The working cost was £14,849, or 3d. per yard, and £1461 was spent at the London office. Out of the profit, £4474 was placed to an account for the amortization of capital, of which we speak elsewhere. The shareholders received £26,000, being at the rate of 20%, free of income tax.

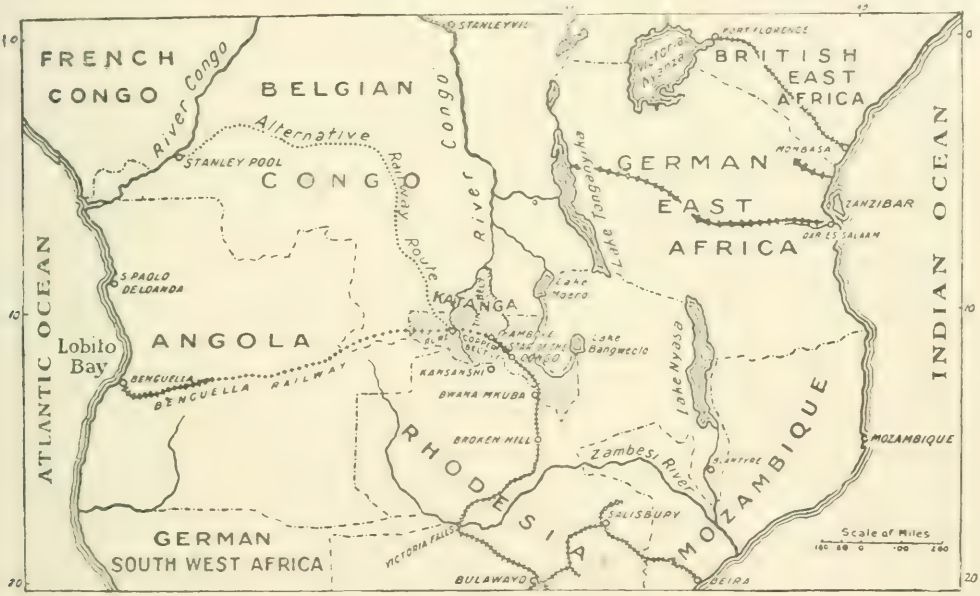
North Broken Hill.—The report for the half-year ended June 30 last shows that operations were greatly restricted by the miners' strike. From January 11 to March 7 no ore was raised or treated. From the latter date to May 6, the men worked 4 days per week, and from May 6 to June 18, 5 days per week. On June 18 the decision of the Arbitration Court in favour of the miners came into force, and thereafter the miners worked 44 hours per week. This was 4 hours less than before, and at the same time the men received 1s. 9d. per day higher pay. Owing to the strike, the mine was worked for only 12½ full weeks out of the 26. During this time, 70,200 tons of ore was treated, averaging 15·5% lead, 12·5% zinc, and 7 oz. silver per ton. The yield of lead concentrate was 13,910 tons averaging 60·9% lead, 8·4% zinc, and 20·1 oz. silver. In addition 34,837 tons of zinc tailing was produced, averaging 15·4% zinc, 3·1% lead, and 3·2 oz. silver per ton, together with 74·96 tons of slime, averaging 12·4% lead, 14·8% zinc, and 8·4 oz. silver. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) company's plant for treatment. Owing to the strike, very little development was done during the half-year. The accounts show a net profit of £131,552, out of which £120,000 was distributed as dividend, being at the rate of 4s. per £1 share for the half-year.

Cock's Pioneer Gold and Tin Mines.—This company was formed in Victoria in 1913 to acquire an alluvial property containing both gold and tin in Reedy creek near Eldorado, Beechworth district, in the northeast of Victoria. The gravel is treated hydraulically and raised by pumps to a floating pontoon containing the sluices. A. H. P. Moline is general manager and the control is with the Baillieu group. The report for the half-year ended May 31 shows that 270,000 cu. yd. of gravel was treated for a yield of 3036 oz. gold, or nearly 11d. per yard, and 33 tons of tin concentrate, or 0·274 lb. per yard. The accounts show credits of £16,067 and a net profit of £3398. Bringing a credit balance of £5318 from the previous half-year made a total balance of £8717, out of which £5000 was paid as dividend, £2348 was placed to reserve for depreciation, and £1000 was placed to general reserve.

Consolidated Main Reef.—This company was formed in 1896 to acquire gold-mining properties in Middle West Rand, owned by the Main Reef and Consolidated Angle-Tharsis, two companies that were formed in 1888 and 1893 respectively. The control is with the Neumann group. David Wilkinson is consulting engineer, and J. E. Healey is manager. Milling commenced in 1888, but was subsequently suspended on several occasions. The first dividend, of 5%, was paid in 1907, and the rate has gradually increased to 12½%. A year ago and two years ago the output of ore was restricted owing to scarcity of native labour. The report for the year ended June 30 last, now issued, shows that labour conditions have greatly improved, and that both output and profits have increased. The ore mined was 387,557 tons. After the removal of 11½% waste, 342,895 tons averaging 7·45 dwt. gold per ton was sent to the mill. The yield of gold by amalgamation was 89,339 oz. and by cyanide 31,150 oz., being a total of 120,489 oz., worth £501,281, or 29s. 2d. per ton milled. The working cost was £338,350 or 19s. 8d. per ton, leaving a working profit of £162,931, or 9s. 6d. per ton. Out of this profit £39,760 was spent on capital account for shaft-sinking and plant, and £12,489 was paid as tax. The shareholders received £115,545, being at the rate of 12½%. The tonnage milled was 48,129 tons greater than the year before, the yield per ton 9d. less, the working cost per ton 11d. less, and the working profit £24,666 greater. The reserve is estimated at 856,740 tons averaging 7·5 dwt. per ton, figures substantially the same as the year before. Progress has been made in sinking the auxiliary internal inclined shafts, and during the current year this work will be continued as rapidly as possible.

Main Reef West.—This company was formed in 1899 to acquire gold-mining property in the middle west Rand, on the dip of the Aurora and New Unified, and to the west of the deep-level section of the Consolidated Main Reef. The control and management are in the same hands as the Consolidated Main Reef, particulars of which are given in the preceding paragraph. Milling commenced in 1909. For 1909-10, the dividend was at the rate of 25%, and subsequent dividends were 22½%, 15%, and 5%. For the years ended June 30, 1914, 1915, and 1916 no dividends were paid. In order to provide the necessary funds for further development, the debenture holders agreed last year that the redemption of the debentures should be postponed for three years. The capital of the company is £491,188, and there are £249,963 debentures outstanding. The report for the year ended June 30 last shows that the tonnage treated was rather greater than the year before, but that the yield per ton was less, and the gross profit rather smaller. The amount of ore raised was 345,252 tons, and after the rejection of 10·9% waste, 307,680 tons was sent to the mill. The yield by amalgamation was 59,824 oz., and by cyanide 21,851 oz., making a total of 81,675 oz., worth £339,672, or 22s. 1d. per ton milled. The working cost was £297,010, or 19s. 4d. per ton, leaving a profit of £42,661, or 2s. 9d. per ton. Out of the profit, £20,813 was allocated to capital expenditure, chiefly on shaft-sinking, £15,000 was paid as debenture interest, and £1340 was paid as tax. The ore reserve is estimated at 386,960 tons averaging 5·73 dwt. per ton, a decrease of 29,320 tons and 0·14 dwt. as compared with the figures a year ago. The ore exposed during the year was 159,100 tons averaging 5·85 dwt., or less than half a year's supply. If it had not been that during the past year a large amount of ore was obtained by reclamation and from development faces, the ore reserve would have shown a greater decrease.

Tanganyika Concessions.—This company was formed by Robert Williams in 1899 to acquire a concession in Northern Rhodesia. Railways have been built and mines developed. Subsequently the company became interested in territory farther north, in the southeastern part of the Belgian Congo, the territory being held by a Belgian Company, the Union Miniere du Haut Katanga. Tanganyika Concessions holds a 40% interest in the Union Miniere. The company has also financed the construction of the Benguella railway, now being built from Lobito Bay, on the Atlantic coast, to Katanga. The great enterprise of the Union Miniere has been the development of the Star of the Congo and the Kambove copper mines. Since the outbreak of war, the mining and metallurgical management of the mines has been undertaken by Tanganyika Concessions, acting as agents for the Belgian company. The report of Tanganyika Concessions for the year 1915 shows that five blast-furnaces are now erected, and that the material for two more, each with a monthly capacity of 600 tons of copper, is ready for shipment. The output of copper during 1915 was 14,190 tons, and for the first nine months of 1916 it was 16,749 tons. Owing to the German occupation of Brussels, the meeting of shareholders of Union Miniere cannot be held, and consequently no distribution of profits can be made. Thus the interest on Tanganyika debentures cannot be paid at present. The report gives details of the Benguella railway, and of the Rhodesia-Katanga Junction Railway & Mineral Co. Conditions have not yet become favourable for the re-opening of the Kansanshi copper mine in Northern Rhodesia. No information is available as to the work of investigation of the Kundelungu diamond pipes. We refer in our Editorial columns to the speech of Robert Williams at the meeting of shareholders



Map of Central Africa showing the centres of activity of Tanganyika Concessions.

North Anantapur Gold Mine.—This company was formed by John Taylor & Sons in 1908 as a subsidiary of the Anantapur Gold Field Limited, the parent company that explored and reopened old workings in Madras Presidency, India. Milling started in 1910, and the plant has been expanded since. Dividends were first paid on the preference shares for the years 1912-13, and small dividends on the ordinary shares followed the next year. The report for the year ended June 30 shows that 32,390 tons of ore was treated, yielding 12,179 oz. of gold by amalgamation, and

24,200 tons of tailing was cyanided for a yield of 1125 oz., making a total yield of 13,304 oz., worth £56,209. The working cost was £38,701, and £7285 was written off. The preference shareholders received £5625, being at the rate of 22½%, and the ordinary shareholders received £1906, being 2½%. Unfortunately, the grade of the ore treated fell during the year, and averaged 8·6 dwt. as compared with 13 dwt. the year before. On the other hand, the working cost was reduced from 30s. 7d. per ton to 22s. 4d. The developments during the past year have been discouraging, as the ground at the chief point of attack, the 950 ft. level north of No. 5 shaft, has proved broken and of low grade. Some of the stopes in the wider parts of the ore-shoot are nearing exhaustion, and it will be necessary shortly to reduce the tonnage sent to the mill, and then to depend on smaller amounts of higher grade ore. The ore reserve is estimated at 44,000 tons, a fall of 9600 tons as compared with the previous year. Plans have been laid for continuing exploration and development.

Oriental Consolidated.—This company was formed in America in 1897 to acquire a gold-mining concession in northwestern Korea, or Chosen, as it is now called. H. C. Perkins is president, and Alf Welhaven is general manager. English shareholders are represented by the Central Mining and Investment Corporation. Dividends have been paid continuously since 1903, and the total distribution has been $7,069,860, or 165% on a capitalization of $4,293,900. The company at present works the Tabowie, Taracol, Charabowie, Chintui, and Tongkol mines, of which the first two are the largest producers, and have separate metallurgical plants. The Maibong mill treats ore from the other mines. During the last year, operations at the Candlestick mine and mill have been suspended as the mine is exhausted. The ore is first treated by amalgamation and then passed over concentrating tables. The concentrate is cyanided, and the table tailing being too low for treatment (averaging 60 cents per ton) is run to waste. The recovery of gold is calculated at 90·2%. The report for the year ended June 30 last shows that 309,730 tons of ore was raised and treated, of which 126,766 tons came from the Tabowie, and 104,097 tons from the Taracol. The gold extracted by amalgamation was worth $947,755, and 30,252 tons of concentrate yielded gold worth $638,134. The total yield was $1,585,889, or $5·12 per ton, the estimated content of the ore fed being $6·04 per ton. Other items brought the total receipts to $1,636,299, or $5·28 per ton. The total cost was $958,479, or $3·09 per ton, leaving a profit of $677,820, or $2·19 per ton. The shareholders received $644,085, or $1·50 per $10·00 share. The ore reserves have been fully maintained, standing now as follows. Tabowie 560,000 tons, averaging $6·15; Taracol 210,000 tons, averaging $4·20; Chintui 20,000 tons, averaging $4·25; Charabowie 45,000 tons, averaging $7·00; Tongkol 7000 tons, averaging $7·50; Sambong 10,000 tons, averaging $4·50; total 852,000 tons. At the Tabowie, a large proportion of the ore developed during the year came from the upper parts of the mine, and the lode is narrowing discouragingly in the bottom workings. At the Taracol, the results of development have been good, and the outlook is better than for some years past.

Tomboy Gold Mines.—This company was floated in 1899 by the Exploration Co. to purchase the Tomboy gold mine at Telluride, Colorado. On the mine showing signs of exhaustion in 1901, the Argentine property near-by was acquired. In 1911 the latter began to go the same way, so another property in the neighbourhood was bought, namely, the Montana group of claims, belonging to the Revenue Tunnel Co. The gold occurs both free and in sulphides, and the ore is first amalgamated, then passed over concentrating tables, and finally cyanided. The report for the year ended June 30 shows that 150,488 tons of ore, of which over 120,000 tons came from the Montana property, was sent to the mill, where bullion worth $327,519 was obtained; at the tables, concentrates worth $586,092 were extracted; at the cyanide plant, bullion worth $160,476 was extracted. The total yield was worth $1,074,088, or $7·13 per ton. The working cost was $720,853, or $4·79 per ton. The accounts show a net profit of £76,923, out of which £30,000 has been written off property, plant, and machinery account, and £17,000 has been allocated to income tax paid and reserved. The shareholders received £31,000, being at the rate of 10%. The reserve in the Argentine group is estimated at 175,000 tons. In the Montana group the reserve has increased by 50,000 tons, now standing at 400,000 tons as compared with 350,000 tons the yearbefore.

South American Copper Syndicate.—This company was formed in 1907 to acquire the Aroa group of copper mines in Venezuela. The property was worked from 1882 to 1894 by the Quebrada Railway, Land, & Copper Co., but mining came to an end in the latter year owing to the caving of the workings. W. A. Heywood was at that time metallurgist, and the new company engaged him to design smelting plant. The furnaces were started in April 1914, but did not work satisfactorily. Before the necessary structural alterations could be made, the European war supervened, and smelting had to be suspended. In the meantime shipments of ore were resumed. Smelting was re-started in 1915. The yearly report now issued covers the period ended June 30. During this time the ore sold was valued at £66,093, and after the payment of freight and smelters' charges the working profit was £22,951. The smelter produced matte valued at £26,071, yielding a profit of £9656. Against the latter profit was charged £7078 previous loss, and £1352 depreciation. The London office expenses were £2557 and the directors' extra remuneration £2148. The net profit for the year was £21,489, and £22,500 was distributed as dividend, being at the rate of 150% on the capital.

Central Chili Copper.—This company was formed in 1894 to work the Panulcillo copper mine, near Coquimbo, Chile, that had previously been operated for many years by the Panulcillo company. Neither the present nor the old company has given much return on the capital invested. The present company paid dividends of 2½%, 2½%, and 5% for the years 1900, 1901, and 1907, and there is some likelihood of dividends being resumed during the current year. The report for the year 1915, just issued, shows that the output of ore was 30,853 tons averaging 2·52% copper, as compared with 28,602 tons averaging 2·84% the year before, the content continuing to exhibit a gradual decline. The company bought ore from other mines aggregating 28,097 tons averaging 8·25%, as compared with 27,160 tons averaging 8·4% the year before. At the smelter, 32,063 tons of the company's ore and 27,826 tons of purchased ore was treated, yielding matte containing 2737 tons of fine copper, and gold and silver worth £10,097. The accounts show a profit of £28,578. The year commenced with an adverse balance of £27,874, and ended with a credit balance of £704. The directors state that satisfactory profits are being made, and that, as mentioned above, it will in all probability be possible to resume the payment of dividends in the New Year.

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EDITORIAL

RESEARCH has received definite official recognition in this country, by the granting of a Royal Charter to the Research Council, and it is announced also that the Government is prepared to provide funds for this object on a scale far exceeding anything yet done in Great Britain. In order to encourage subscriptions from industrial companies, to be applied to the promotion of education and scientific investigation, the Treasury has agreed to class such allocations of profits as working expenses, so that they shall escape income tax and excess profits tax. A great many liberal gifts have been recorded recently having for their object the endowment of scientific education. Among the beneficiaries, we note with interest the Swansea Technical College.

THE Government does not favour publication of information relating to wolfram and tungsten at the present time, but this rule was relaxed when representatives of the press were invited last month to visit the tungsten works of the High-Speed Steel Alloys, Limited, at Widnes. The process employed there is roasting with carbonate of soda, reduction of the resulting tungstate of soda to tungstic acid by reaction with hydrochloric acid, and the reduction of the tungstic acid to metal powder by anthracite in a gas-heated furnace. The company has recently purchased two properties in Burma, where the business is in the hands of Dr. W. R. Jones.

DURING the last two years we have on several occasions protested against the popular notion that all useful scientific inventions come from Germany. This question arises once more in the case of the Messerschmidt process for producing hydrogen, which is described by Mr. H. L. Barnitz at great length and with profusion of illustration in our New York contemporary *Metallurgical and Chemical Engineering*. The article is given the appearance of extra importance by being headed "Copyright." As noted in our Mining Digest, this is a continuous process in which spongy iron is alternately oxidized by steam with the formation of hydrogen, and deoxidized by water-gas. The same process is, however, well known in this country, for plant on the identical system is made by Mr. Howard Lane, at Ashford, Middlesex. Mr. Lane took out a patent in 1903, and exhibited his plant at the St. Louis exhibition in 1904.

OF recent years little was seen in public life of the late Charles D. Rudd. He was an associate of Cecil Rhodes in founding the Consolidated Gold Fields of South Africa and in obtaining concessions from King Lobengula. With Rhodes he represented the university element among the South African pioneers, having been educated at Harrow and Cambridge. We believe we are right in saying that he was the anonymous benefactor who provided such large sums for the Hospital for Diseases of the Chest, first at Hampstead and later at Northwood.

THE high prices of zinc has led the metallurgists at gold and silver mines to seek alternative methods of precipitation from cyanide solutions. The users of aluminium dust at Cobalt have been constrained to modify their process for the same reason. In America experiments are being made with electro-deposition on lines similar to the Siemens & Halske process used many years ago on the Transvaal. Rand metallurgists have recently turned their attention to the recovery of the zinc, and in the course of their investigations have evolved a new method, of which more will be heard later. At the Nipissing mine, Cobalt, sodium sulphide is now employed as a precipitant. This method is described by Mr. R. B. Watson, the manager, in a paper printed in another part of this issue.

ANNUAL meetings of the Consolidated Gold Fields of South Africa are always interesting functions, though of late years conditions have not been favourable to large dividends. Opportunities for making profits by disposing of assets on a rising market have been scarce or non-existent of recent years. Of the properties controlled by the company in the middle east Rand, the Simmer and Jack is nearing its end, and the deep level mines are of very low grade. The Rhodesian enterprises have on the whole been disappointing, and the capital of the Gold Fields Rhodesian subsidiary is having to be written down. The most interesting of the new ventures is that of the American Trona Corporation which is now producing potash and borax at Searle's Lake, California, as recorded in our issue last month. The pleasant feature of the meeting was the interchange of kindly speeches commemorating the completion by Lord Harris of twenty-one years service as chairman of the company. It seemed like old times to see Mr. Stanley Christopherson bowling so well for his captain. Lord Harris won the admiration of the present editor of this Magazine as far back as 1883, when he hit a ball to leg for six out of the Old Trafford cricket ground. Those who achieve fame in cricket make men of integrity in business life.

ELSEWHERE in this issue we publish Dr. George S. Corstorphine's report on the Shamva orebody. This report gives a straightforward statement with regard to the chance of finding a continuation of the orebody below the fifth level, and shareholders will have to take from it what comfort they can. The reason we quote the report in full is that full justice shall be done to the writer's theory of the geology of the ore deposit. The theory is subversive of that generally accepted, and therefore requires a close examination. The report should be read in conjunction with Mr. F. P. Mennell's communication printed in the Discussion pages. Briefly, Dr. Corstorphine says that the rock containing the gold is not a mixture of quartzites and metamorphosed conglomerates, but a fine grained igneous rock. As the rock extends over thousands of square miles in Rhodesia, the difference of opinion between geologists is of wide importance, and the discussion is not confined to the occurrence at one particular mine. In fact, Dr. Corstorphine upsets Rhodesian geology generally, and we are not inclined to be in any hurry to accept his theory. No doubt other geologists who know the country will give their views.

NEWS is to hand as we go to press that Minerals Separation has won its case against James M. Hyde in the Supreme Court at Washington. Thus the soundness of the Sulman-Picard-Ballot patent of 1905, claiming the use of a fraction of 1% of oil, is finally established. The decision of the Appeal Court is overthrown, and the judgment of the Montana Court restored. Two months ago the Delaware Court gave a judgment in favour of Minerals Separation in the Miami suit in connection with the Callow process. In view of the decision of the Supreme Court in the Hyde case, it is not likely that the Miami appeal will be continued. The present judgment will have far reaching results.

MR. Justice Eve's decision in favour of the defendants in the case of the Amalgamated Properties of Rhodesia versus the Globe & Phœnix may be described as a "terrible disaster" to the economic geologist. He listened in courteous mood to their disquisitions on vein formation and ore deposition, but their arguments tending to show that different parts of the reef system were formed at different geological epochs made no impression on him. Instead, he accepted the evidence of the miners who had stoped the chief disputed ground. In any case he considered that for the practical purposes of the mining law the reef system was continuous, even though it might not be a genetic whole. It was not intended, he said, that a prospector should arm himself with more than a pick, shovel, candle, and stick of dynamite; it was not required of him to carry a geological library on his back. Frankly we confess, with great respect, that mining men share the feelings of the experts engaged on both sides in this case, and are disappointed that the judge should show so little sympathy with geological studies. The moral of it all is that economic geologists, like the flotation engineers, are more usefully employed in the field and at the mine than in the capacity of expert witnesses, and that Cecil Rhodes made one of his many mistakes when he imported the law of extra-lateral rights from America. On another page we quote the main points of the judgment.

THE acceptance by the Union Government of the proposals of the financial houses with regard to the new leases in the Modder and Brakpan areas clears the atmosphere with regard to the future of the Far East Rand. The terms, as far as they have been published, appear to be reasonable from the point of view of both parties. In the meantime, the suggestion for State participation, made by Mr. Ernest Williams in our last issue, is receiving serious consideration in many quarters. In reply to requests for further details of his scheme, Mr. Williams will present plans and calculations in our January issue.

WITH this issue we commence the publication of a series of articles on "Bucket-Dredging for Tin in the Federated Malay States," written by Mr. Harry D. Griffiths. It is hardly necessary at this time of day to present Mr. Griffiths' credentials as an authority on alluvial tin-mining. As regards the subject matter, the application of bucket-dredging to the treatment of alluvial tin deposits forms one of the most important advances in mining practice during the last ten years. For this progress, the Australasian engineers are to be chiefly thanked. Their first activities were directed to the Western Siamese States, which are situated in the isthmus connecting the Malay Peninsula with the Asian continent. The Tongkah Harbour Tin Dredging Co. was the pioneer, being formed in Tasmania in 1906. This company was, however, not far ahead of the Renong company and the Siamese Tin Syndicate, which were formed in London later in the same year. Attention was paid to the Federated Malay States a few years afterward, and the first of the companies, the Malayan Tin Dredging Co., was formed in London in 1911. The introduction of bucket-dredging was not effected without having to overcome great obstacles. The Tongkah Harbour controversy formed a bitter episode, as readers of our issues in 1910 will remember. More recently the Ipoh Company was in difficulties owing to some of the larger shareholders not paying their calls, but the Borneo Company came to the rescue. Mr. Griffiths, in his article, gives the reasons for the doubts with regard to the applicability of bucket-dredging to the alluvium of the Federated Malay States, so we need not pursue the matter further in this introductory note. As to the honourable mention of the engineers who have fought prejudice and brought the system of treatment to success, the firms of F. W. Payne & Co. and Cutten Brothers deserve special recognition as designers. Credit is also due to firms who have built the dredges, namely Werf Conrad, Wm. Simons & Co., Fraser & Chalmers, and A. R. Brown. In succeeding articles, Mr. Griffiths will discuss the details of some of these dredges, and will give drawings of the noteworthy parts of their construction.

The Excess Profits Tax.

The protests of the mining industry against the incidence of the excess profits tax are having effect, though slowly and with difficulty, in the councils of the Inland Revenue Department. On three heads alterations have been urged. In the first place, mining is full of risks and therefore an investor expects more than 6% on his money; secondly, a mine is a wasting asset and allowance ought to be made for amortization; thirdly—and this applies to other businesses as well as mining—excess profits should not be counted from the zero of the start of operations. Last month we recorded that the Malay tin companies are to be allowed to make 13% before the excess profits are assessed. Since then we have heard that the Nigerian tin companies will be placed on the same footing.

Unfortunately this rate is considered by the Revenue officials sufficient to cover amortization as well as interest on money invested. This, however, is not good enough. The business committee of the Institution is labouring to secure the specific recognition of risks and the necessity for redemption of capital, as well as for the postponement of excess assessments for new companies, and we hope they will be able to make a still stronger impression on the referees. The indications at present are that substantial concessions will be granted to all classes of mining, and in respect of all three items.

We take it that the excess profits tax was devised solely for the purpose of steadying the big profits made by contractors and by manufacturers or producers of materials required for the war. When it was found subsequently that the wording of the Act included everything and everybody, the Treasury accepted their luck and said as little about it as possible, so as not to raise a storm of opposition at the time. It is true that astute parliamentarians and city men correctly interpreted the proposals, and warned us of their application to mining. But most of us took no heed of the warning, never suspecting that the Government contemplated so irrational and destructive a policy. It is no use repining, however; it is necessary instead to employ our efforts in ameliorating the position.

It is so obviously unjust that a company should pay excess tax from the beginning of its profit-earning period that little argument is needed in protesting against it. Our own view is that a company should not pay excess tax until at least the second year of distribution of profits, and then only on the basis of the previous year's results; in fact that the years of establishment of the business should not be counted when the assessment is made. At the present time capital fights shy of assessment from the beginning, and many ventures are hung-up for this reason. It may be urged that the Government's wish is actually to prevent the formation of new businesses in time of war; but it is to be remembered that the authorities already have this power and can exercise it through other channels.

The troubles of mining companies in connection with the rate of interest allowed on money and the means of providing untaxed funds for redemption of capital are mostly of their own making, owing to their unbusinesslike methods in the past. It is only since the great advance in income tax and the imposition of excess profits tax that we have heard much about the risk of mining demanding a big return, and about the mine being a wasting asset. In the old days the desire in most quarters was to pay a high rate of dividend and let the future take care of itself. The object usually was to press the Stock Exchange quotation upward, and to enable the first shareholders to realize at a high price, the second or third generations of shareholders being left to take their chance. Even when new shafts or new plants were required, profits would first be distributed, and then the money called up again on the issue of additional shares. Of late years it has been the custom, owing largely to the force of circumstances, to pay for extensions as far as possible out of revenue.

It has always been the practice to make allowance out of profits for the depreciation of plant, but few companies have written the value of the mine off the property account. If it had been the custom to treat the property as a wasting asset, and to disburse profits partly as dividend and partly as return of capital, the present difficulties would not have arisen. We have a good deal to say on this subject of company administration, and on the relative advantages of alternate methods. Also we could quote specific examples of the ideal way of regulating company finance. These details demand consideration in a separate article, one not devoted specifically, as this one is, to the immediate incidence of the excess profits tax. We shall therefore postpone their exposition until next month.

A Cornish Chamber of Mines.

A month or two ago fears were expressed both in London and Cornwall that the scheme for establishing a Cornish Chamber of Mines would prove abortive. We are glad, therefore, to be able to record that during the last few weeks substantial progress has been made, and that a constitution has been drawn up by the representative committee appointed at the preliminary meeting held last June. It is possible that before these lines are printed formal registration of the Chamber will have been made under the Companies Acts. Wide powers are taken by the memorandum and articles of association. Briefly the main objects are: (1) to advance, promote, encourage, and protect the mining interests of Cornwall and Devon by the consideration and discussion of all questions connected therewith; (2) to promote or oppose legislative measures, or petition the Government or any administrative body on any matters directly or indirectly affecting the aforesaid interests; (3) to collect statistics and information calculated to be of service to the industry; and (4) to act as arbitrators in the settlement of any dispute arising out of mining or touching the ownership of mining properties in Cornwall and Devon. We note with satisfaction that the County of Devon has been included, and also that the china-clay and the granite and slate industries are included in the interests to be guarded by the Chamber. The power to oppose legislative measures and to petition the Government is a desirable safeguard in these times. Much could have been done for instance in connection with the Insurance Act, the Military Service Act, and the Excess Profits Duty if the views of the industry could have been made known to the authorities before the measures were actually brought into operation. The value of reliable and prompt statistical information is sufficiently obvious, while the fact that the Chamber is willing to provide means for arbitration in disputes and other matters will surely prove of service.

The membership of the Chamber is to be divided into four classes: ordinary, associate, honorary, and visiting members. The ordinary members will be elected from companies and individuals holding mining property or directly connected with the industries named; and any persons interested in mining in Cornwall and Devon will be eligible as associate members. The annual subscription for ordinary members has been fixed as follows: (*a*) For companies not in the producing stage, £5 5s. 0d.; (*b*) For companies in the producing stage, either 1s. per person employed plus 5s. per £1000 of moneys received for ores produced during the preceding 12 months, or 2s. per person employed; (*c*) For mineral owners not receiving dues or rents (more than nominal), £5. 5s. 0d.; (*d*) For mineral owners receiving dues, for every £1000 received during the preceding 12 months, £5. 5s. 0d.; (*e*) All other ordinary members, £1. 1s. 0d. Associate members will pay an annual subscription of half a guinea, but will have no voting power. Ordinary members will have one vote each, and in the case of companies and mineral owners one vote for each £5 of subscription with a maximum of twenty. Companies and mineral lords may be represented by directors, officials, or agents. The governing body will be a council consisting of not less than seven nor more than twelve ordinary members, and one-third of their number will retire annually, but will be eligible for re-election. Until the first council is elected, the subscribers to the memorandum will act in that capacity. From the council will be elected a chairman, and two vice-chairmen. The council will have power to appoint paid officials to conduct the work of the Chamber. The secretary will of course be the chief stipendiary, and on him will rest most of the work and a large share of the responsibility for making the organization a power in the land. No public announcement has so far been made as to the prospective appointment. It is a matter of prime importance that the holder of this office should have a thorough knowledge of local conditions, unbounded energy, and tact.

A British Trade Bank.

Two months ago an announcement was made with regard to the establishment of a Trade Bank, the function of which would be to finance commercial undertakings and to facilitate overseas interchange of trade. Of recent years it has been the grievance of owners of undeveloped properties, and the originators of promising schemes for the establishment of profitable trade, that financial aid is not easily obtainable. However sound the proposals may be, bankers are not inclined to consider them, because, according to present custom, their money must be placed against securities and at immediate or ready call. If the proposer has no capital of his own, and has no rich friend that trusts him, he must have recourse to a merchant, who saddles him with an onerous contract, or to a promoter who finds the money from somebody else and charges disastrously for his services. It is pointed out that, in Germany, the banks have always been ready to employ their funds for the establishment of industrial and other businesses, even though it involved a temporary lock-up of capital and a deferment of interest or profits; and we are asked why these methods cannot be introduced in this country. To put such a question shows unacquaintance with the history of British banking. In the old days the banker used to lend money in this way. Knowing his customers personally, and being able to judge of their ability and integrity, he was able to place the money under his control in profitable trading ventures. A forbear of the editor of this Magazine was a banker of this description in the North of England, and he was able to benefit both his depositors and his county by helping to finance the development of iron and coal mines and the establishment of iron and steel manufacture. But times have gradually changed since then. The London banking octopus has spread its tentacles throughout the land, and the personal element has been gradually eliminated. Nowadays it is impossible to obtain an advance from a bank without lodging ample and easily realized collateral. The extreme case of the revolution of methods is seen when an English bank will lend money to a German bank so as to enable the latter to discount bills given by English firms to German commercial houses, while at the same time it will not afford these facilities for promoting trade between English buyers and English manufacturers. We know the attitude of the English banker, and we value the soundness and the uprightness of his methods within the bounds which he has set round himself. It is true, as he urges, that he is a trustee for his depositors, that he must not risk their money, and that borrowers must give first-class security. It is also true that power to exercise individual discretion as to the soundness of a business proposition might be abused, and that either by wilfulness, carelessness, or lack of capacity a manager might play havoc with the funds at his disposal. We grant all this, and we agree that the deposits on current or deposit account, as at present defined, should not be applied for the establishment of new businesses. Our own proposal is that the scope of the bank deposit should be widened by the inauguration of a "No. 2" deposit account, the funds of which would be available for industrial investment. Deposit accounts at present are as a rule withdrawable at short notice and the interest on them varies with the bank rate, though of course special arrangements may always be made both as to notice and rate of interest. Our "No. 2" deposit account would be at fixed rate, and with long notice of withdrawal. Eighty per cent. of the total of these deposits could be invested with the proposed British Trade Bank. We are averse to each bank investing the funds of its "No. 2" deposit account direct in trade and commercial enterprises, for the expenses of management and of technical inquiry as to the prospects of proposed businesses would be too great, and moreover a great deal of duplication would occur; whereas a central Trading Bank could afford to pay for the best business and technical advice, and to investigate thoroughly the bona fides of customers and the soundness of their proposals. That is our suggestion, put broadly. The rate of interest on the deposits, and whether the term of notice of withdrawal should be six months, or one or more years, could be settled only after careful inquiry. Naturally the fact that money invested in the Trading Bank would not be immediately remunerative would have to be taken into account in arranging the terms of deposit with the individual banks. The banks would have to assume full liability for the deposits, but as the rate of interest payable would be comparatively low, the possible profits large, and the maximum total amounts of such deposits fixed at the discretion of the bankers, the risk to the bankers would be small. The fixing of the interest and the bankers' guarantee of the deposits would induce individuals and trading companies to place some of their surplus cash in this way. If any customer desired to realize at an earlier date than the statutory period of withdrawal permitted, he would have no difficulty, for the bankers' certificate of deposit would be easily negotiable. We put forward this concrete proposition for the participation of bankers in commercial ventures, in the hope that, as a contribution to public opinion, it may help to provide means of expanding the bnsiness interests of the Empire.

Thoughts on Flotation.

Many communications have been made to us in comment on our editorial last month in which we discussed the debt owing by the mining profession to the Elmores. Some of our correspondents say we make invidious distinction among the various inventors and patentees, by laying too much stress on the work of the Elmores, and by neglecting to record the equally important early work of Messrs. A. E. Cattermole, H. L. Sulman, and H. K. Picard. They argue that as the Minerals Separation process, which was based on the patents of the last named inventors, has proved more commercially valuable than either of the Elmore processes, at least equal recognition should be given in the press to their services in evolving the flotation idea. It is pointed out that Mr. Cattermole deserves special recognition, seeing that he was the first to use quantities of oil so small as to preclude any oil-buoyancy effect upon the mineral. It was indeed through the investigation of his process that the froth-flotation methods used by Minerals Separation were discovered. We have never been able to say as much about the Minerals Separation process as our readers would like, for the company imposes silence on all its employees and patentees with regard to the technology of the process during the period of litigation, and it is obvious that any authoritative discussion of early work is thereby precluded for the present. When all these lawsuits are ended, we shall be able to give the full history and be in a better position to apportion the credits. In this connection we take the opportunity of drawing attention to the fact that the new book published in America entitled "The Flotation Process," written by Mr. H. A. Megraw, ignores entirely the names of Sulman & Picard, and that the author in his historical account of the flotation method of concentration makes no mention of their contribution to the art or to the early development work done by Minerals Separation. It is to say the least a pity that there should be an omission of this sort from a book that is intended to be a comprehensive treatise on flotation. Correspondents have also urged that due credit should be given to Everson, Potter, and the rest of the pioneers. We shall do this on some other occasion; but for the present we will let these matters rest.

We have received questions with regard to our remark that the Elmore vacuum patent of 1904 indicated the use of small quantities of oil and that in this way it anticipated the Sulman-Picard-Ballot patent of 1905, which forms the basis for the actions taken by Minerals Separation in America. It is pointed out to us that the 1905 patent depends specifically on the claim for a fraction of 1% of oil, whereas the 1904 patent is more general in terms. It is also true that the Froment patent of 1902 mentions the use of small quantities of oil in conjunction with bubbles, and that Messrs. Sulman & Picard's patents of 1903 also specified small quantities of oil to be used in the same way. Thus, though Minerals Separation could use their best patent, that of 1905, in attacking the later processes of Callow and Hyde, Elmores could not attack that patent by theirs of 1904, as the Froment and Sulman & Picard patents of 1902 and 1903 antedated them in this respect. On the other hand, the Froment and Sulman & Picard patents cannot be taken as anticipating the vacuum patent.

In our article we also referred to the fact that the Callow process resembled the Elmore vacuum process in that it employs the rising and expanding bubble for lifting the oiled minerals. In continuation of this idea, it is interesting to note that the introduction of the lifting air through porous bottoms is employed by other inventors besides Mr. Callow. Indeed, he is definitely anticipated by the patent of Mr. T. J. Hoover and Minerals Separation, No. 10,929 of 1910. The first claim of this patent reads thus: "The method of introducing air or other gas into an ore pulp for the purpose of effecting flotation of certain particles, which consists in bringing the ore pulp into contact with a porous medium through which the air or other gas is caused to pass." Another claim describes the agitation of the ore pulp with a mineral-frothing agent, and the passing of the ore pulp over a trough having a porous bottom through which air or other gas under pressure is forced. In the body of the specification examples of the porous material are given, including porous brick, and felt or other fibrous material suitably supported. Three machines working on these lines, besides the Callow, have recently been introduced in America. The Flinn-Towne machine uses a porous brick bottom; in the Cole-Bergman cell the compressed air is forced upward through perforated metal pipes arranged side by side at the bottom; the Inspiration cell is a modification of the Callow. Some notes of these three machines are given in our Mining Digest, and the Callow cell was described in our issue of January last. Reference to the introduction of air at the bottom of the cell would not be complete without mentioning that the "sub-aeration" machines made by Minerals Separation on the basis of the patent of Mr. James Hebbard, of the Central mine, Broken Hill, employ buoying air as well as air entrapped by agitation. This class of machine is, in fact, employed at Anaconda, as described in our issues of April and July last. Readers may receive the impression from the above remarks that opportunity is afforded for further litigation. This trouble, however, is not likely to arise with regard to the principle of upward bubbles entering through porous bottoms, for, on the one hand, Mr. Hoover apparently has no American patent on the subject, while, on the other hand, the publication of his English specification has the effect of freeing the process in America.

Standardization of Mining Machinery and the Metric System.

The standardization of mining machinery and plant and of the units of weights and measures occupied the attention of the members of the Institution of Mining & Metallurgy who assembled for an informal debate on the subject on the 16th of last month. Mining engineers share with others the desire to see British machinery holding its own throughout the world, not only by virtue of good workmanship, but also by the advantage of convenience to the user. In this matter of convenience two different aspects are to be considered. In the first place the sizes and dimensions should agree with the practice of foreign customers as regards the units of weight and measurement. Secondly, the sizes and method of manufacture of machines and their component parts, and also of the many accessories at a mine or metallurgical plant, should be so standardized as to render design, erection, and renewal as easy and economical as possible. Mr. Humphrey Morgans, who opened the debate, gave many examples of the difficulties of a mining engineer who is called upon to specify for such things as wire ropes, air and water pipes, steam engines, rock-drills, etc. Each individual maker appears to work on a different standard. As an instance of inconvenience arising from lack of standardization, Mr. Morgans quoted the case of a wire rope requiring renewal in parts; if the quick delivery of additional lengths of the same make is not secured, that rope may have to lie idle, for there is difficulty in splicing when there is unconformity in the size and number of the wires, the number of strands, and the disposition of the wires in the strands and of the strands in the rope. In reply to Mr. Morgans, Mr. Walter McDermott, in voicing the views of manufacturers, argued that the want of uniformity of standards was in many ways due to the changing requirements of the engineers in charge of the design, and he quoted as an instance the continual variation in the demands in connection with the structure of stamp-mills. The expense incurred in the drawing office, and in preparing models to meet each requirement, constituted a serious addition to the cost of manufacture, and for this reason, if for no other, he was personally with the advocates of standardization. Other speakers pointed out that the limit of advantage to the community must be considered in connection with standardization. Here the meeting drifted away from the original subject of discussion, and reference was made to the aims and objects of the Federation of British Industries, as described in our October issue; that is to say, the prevention of overlapping of work and needless duplication and competition. This principle, if carried out with perfect altruism, would no doubt be ideal. If the manufacture of each class of machinery were allocated by agreement to each maker, needless competition between individual firms and unnecessary duplication of effort would no doubt be avoided. On the other hand, however, this absence of competition might be to the detriment of the user, for the maker could practically dictate his own terms and use his own discretion as to the quality of the material and workmanship. Then again, inventive genius would be discouraged, and all useful innovations would be blocked by disinclination to alter patterns. To go back to the main argument, our own view is that many standardizations in connection with mining can be effected to secure simplicity and convenience without interfering with efficient design or with healthy competition. We must not expect the reforms to be introduced rapidly, or even the advantageous application of the principle in individual cases to be readily recognized. Old methods cannot be removed by one comprehensive sweep. Standardization can only be applied gradually, and as opportunity offers.

The most practical suggestion made at the meeting was that the Institution of Mining and Metallurgy and the Institution of Mining Engineers should join the Engineering Standards Committee. This committee was founded many years ago by the Institutions of Civil, Mechanical, and Electrical Engineers, and the Iron and Steel Institute, and has so far issued seventy-five reports on standardization in a variety of subjects, from structural steel for ships, bridges, and buildings to portland cement and broken stone. To join the committee will involve the two mining institutions in financial obligations, but the expenditure will be well applied. By becoming associated with engineers who have already gained much experience as to possibilities in standardization, mining men will be better able to judge rapidly as to the extent that the principle can be applied in their own particular line.

The allied subjects of units and the desirability of adopting the metric system occupied the preponderating proportion of time at the meeting. Though some humorous remarks were made questioning the necessity for a change, the general attitude of members was one of readiness to accept its compulsory adoption. But one member recommended that at the close of the war the Allies should adopt the English units of weights and measures; we may with equal jocularity, ask: Which units? Another speaker gloomily predicted very grave difficulties in the path, but as he failed to give specific objections, we may encourage him by saying that perhaps the bogeys were only creatures of the imagination evolved from the cloud of doubt. Similar bogeys were seen when the late William Willett proposed to give us another hour of daylight. Where are those bogeys now?

We need not say more on this occasion with regard to our own views as to the advisability of adopting the metric system and of using units carefully and explicitly, for we wrote on the subject at some length in our issue of October 1915. We should like to remark, however, that at the meeting nobody mentioned the use of the word "unit" in connection with weights, signifying one hundredth of a ton. Mr. Ernest R. Woakes gave us a long list of variations in the methods of estimating ore and metal content, but did not refer to this awkward use of a word. A man is told that a year ago he could sell wolfram concentrate on the basis of 55s. per unit containing 70% WO_3, and he immediately asks what in thunder is a "unit"? This is really the slackest use of a word we know in mining. The origin of the custom is sufficiently clear, for it arises from the method of assessing the value of an ore per ton on its percentage of metal, basing a certain value on a certain percentage with an addition or subtraction of price per unit of percentage above or below. But to extend the use of the word "unit" to mean a unit weighing 22·4 lb., or 20 lb. as the case may be, is quite illogical.

To sum up, our general attitude is a strong bias in favour of immediate adoption of the metric system. We give every encouragement to a cautious establishment of standards in mining machinery and plant. As for reform of the British system of coinage, no internal alteration can give any advantage. If there were three sorts of shillings and five kinds of pence, a domestic reform would be necessary. But as everybody knows what a pound, a shilling, and a penny means (there being no pound scots nowadays), there is little need to legislate thereon. When the time arrives to consider an international revision of money units, the advantages of a departure from the British system may be discussed. But not until then.

REVIEW OF MINING

Introductory.—Much has happened during the last month. The Germans have over-run Roumania, and the Allied forces having their base at Salonika may now expect increased pressure from the north and a contemporaneous attack from the Greeks on the south. The submarine menace is assuming alarming proportions. The Government of this country has been in the melting pot. Strikes in New South Wales have interfered with the coal output. The Welsh coal trade has come under Government control. The price of copper has mounted to an unheard-of level, and silver is once more on the up grade. The Government has taken control of copper. As regards events in the mining world, the acceptance by the Union Government of tenders for the new areas in the Far East Rand has had an excellent influence, as the future agreement of the Government and the financial houses is thus indicated. The judgment in the Globe & Phœnix case has been delivered, and the lack of sympathy with the economic geologists which it discloses is disconcerting to the scientific mining man.

Transvaal.—The output of gold on the Rand during November was 756,370 oz. and in outlying districts 26,696 oz. making a total of 783,066 oz., worth £3,326,353, as compared with 764,489 oz., 27,850 oz., 792,339 oz., and £3,365,642 in October. The number of natives employed on the gold mines at the end of November was 196,132, as compared with 199,330 at the end of October.

As foreshadowed in our last month's issue, the Brakpan area offered for tender by the Government is to be acquired by Brakpan Mines, and the Modder East area has been awarded to the Central Mining & Investment Corporation. The Brakpan area will be incorporated with the present Brakpan property; £850,000 is to be spent in development and in extension of the treatment plant; in addition to the profits tax, the company agrees to pay a further 5% on profits during the next five years, and thereafter the contribution will be on a sliding scale with a minimum of 12½%. The Modder East will be amalgamated with the Cloverfield and Rand Klip; the terms involve the payment of a 10% royalty in addition to the profits tax.

Evidence is still being given before the Commission on State Mining, but the most interesting pronouncement on the subject was given elsewhere, that is to say, by Mr. S. B. Joel, in his address to the shareholders of the Johannesburg Consolidated. His view is that a Government might cheerfully enough go into a mining venture that is an assured success or promises definitely to become one, but that after obtaining poor results from the first developments, the authorities would probably decide, and rightly so, to risk no more public money in the venture. For instance, in the Government Gold Mining Areas, worked by the Johannesburg Consolidated, the early results would have induced a stoppage if the operations had been under Government control. The financiers could, however, afford to take further risks, and the results in this case had fully warranted the speculative expenditure.

The diamond position in South Africa continues to improve. The Premier company has joined the selling syndicate, so that the disposal of the African output will in future be under one control.

The Sub-Nigel company has added substantially to the reserves, and present development indicates a further increase both in quantity and assay-value. In depth the ore-shoots in two sections are longer, of greater width, and of higher content than they were above. The directors may consider an expansion of the plant to treat 11,000 tons per month instead of 8000 tons as at present. This company has not hitherto done particularly well, and could never be compared with the Nigel in the old days. Now that the latter is in low water as regards reserves, the success of the deep level mine is of special interest.

The Messina copper mine presents an excellent example of the severity of taxation nowadays. For ten years the company has struggled with adverse circumstances, and the first divisible profits come at the time when the excess profits tax holds sway. Out of £221,000 profit, this tax takes £105,000, while in addition £13,000 is paid as income tax, and £42,600 is claimed by the South African Government for profits tax and war levy. Altogether £160,600 is paid away as taxes, and the shareholders receive only £60,000. The only comfort the tax collector can give is to smile and quote the billiard-player's comment: "hard lines."

The Ookiep mine of the Cape Copper Co., Namaqualand, continues to yield small amounts of high-grade ore. During the year ended April 30 last, 1683 tons averaging 26% of copper was shipped to Britonferry near Swansea. In addition 11,813 tons averaging $10\frac{1}{2}$% was smelted locally and the matte shipped. At the Nababeep, 72,000 tons averaging 3·7% was smelted. The smelting operations have been curtailed in order to economize fuel. Only one furnace is now in use, and ore of higher grade is being mined. The Rakha Hills mine in Chota Nagpur, India, has not yet arrived at the productive stage. The concentrators have been erected, but war delays have prevented the completion of the blast-furnace. No date can yet be given for the commencement of smelting.

Rhodesia.—The output of gold during the month of October was worth £325,608, as compared with £322,036 in September and £339,967 in October a year ago. The Cam & Motor treated only 11,718 tons as compared with 13,355 tons in September, and the month's work resulted in a loss. Mr. Robert Allen is returning to the mine with the object of investigating the metallurgical difficulties once more, caused by the antimony and the gold now occurring in a different way from before. Statements were publicly made relating to a reconstruction of the company and a reduction of the capital, but the directors inform us that they have no intention of following this course. The difficulty of maintaining supplies of payable ore at Golden Kopje continues, and the output is falling again.

The proposals for the reduction of capital and working expenses of the Gold Fields Rhodesian Development Co. were submitted to a meeting of shareholders on December 12. The denomination of the shares issued or agreed to be issued is to be written down from £1 to 10s., and the nominal capital will thus be reduced by £1,257,110. Also the unissued £1 shares will be split into two of 10s. each, and whenever any are issued, they will be offered first to the present shareholders. The Consolidated Gold Fields agrees to reduce its management fee from £10,000 to £6000 per year, and its annual charge for office rents and secretarial services to £9000. The directors' fees are to be cut from £5000 to £3200 per year, and an arrangement has been made whereby they retire in rotation, as is the custom with other companies. This Rhodesian venture has been a disappointment, and no dividend has ever been paid.

On another page we refer to Dr. Corstorphine's report on the Shamva mine. Mr. H. A. Piper, the consulting engineer to the company, has announced since that he intends to start exploratory work as soon as the necessary labour is procurable, this work to cost about £6000. He also announces that ore is being mined from a new open-cut to the west of the main workings, and that prospecting for this orebody is to be started from No. 1 level.

The Jumbo mine has been producing since 1906, and the total yield of gold has been worth £621,528, obtained from 320,027 tons of ore; but no dividend has ever been paid. During the last year or two the deposit has been on the verge of exhaustion. It has been decided this month to acquire the property of the Tip Top company, but before doing so the issued capital, £350,000, is to be reduced to £48,750, by writing down the par value from £1 to 1s. 6d. The unissued capital will be rearranged, and 300,000 shares of 1s. 6d. each will be paid for the Tip Top mine. This mine belongs to a company in the same group, and has been sufficiently developed to disclose 15,370 tons of ore averaging 12 dwt. per ton over 30 inches. It is admittedly only a small mine.

West Africa.—The output of gold during October was worth £132,577, as compared with £127,138 in September, and £141,771 in October last year. We note that Ashanti Goldfields resumed its normal rate at £40,000 per month, having overcome the difficulty due to shortage of anthracite for the gas-producers. Prestea Block A and Abbontiakoon also showed increases.

Developments at the Ashanti gold mine continue to be excellent. The ore in the Obuasi shoot on the 16th and 17th levels has been proved to be equal in value to the ore above. Only 230 ft. and 80 ft. respectively have been driven on these two levels, but already 38,000 tons of ore averaging 28·6 dwt. has been disclosed. The reserve in the Obuasi now stands at 327,600 tons averaging 29·9 dwt., as compared with 266,900 tons averaging 28 dwt. a year ago. The Obuasi shoot now provides the largest part of the ore treated, for little is extracted from the old part of the Ashanti mine, and much of the Ayeinm ore is too low in grade. During the year ended September 30, the mills treated 127,283 tons of ore, of which 79,044 tons came from the Obuasi, 2250 tons from the old Ashanti, 31,570 tons from the Ayeinm and 14,419 tons from the Old Chief. The yield of gold was worth £473,229. The net profit was £173,281, out of which £154,428 went to shareholders. The yield per ton was 69s. 5d. and the cost 44s. 11d. The cost per ton was about 5s. higher, owing as to 2s. to the greater cost of mining Obuasi ore than the ore from the outside low-grade mines, and as to 3s. to the greater cost of materials due to war conditions.

Affairs at the Taquah mine appear to be in excellent shape in every way. In the first place, the anxiety with regard to the future of the main orebody below the 13th level has been relieved by the results of boring and sinking below the disturbed ground. Then the new ore-shoot to the south is developing well, and the average assay-value of the present workings is higher than where the shoot was first found, being approximately the same as that of the main orebody, 55 to 60s. per ton. The reserve is estimated at 209,000 tons averaging 56s. 9d. per ton over 62 inches, this being sufficient to keep the mill going for three years. The gold extraction is good, only 1s. 6d. out of 60s. being left in the residues. Taquah banket presents none of the metallurgical difficulties that are characteristic of Ashanti and Prestea ores. The history of the Taquah company reflects the troubles of mining in West Africa. From 1888 to 1912 one worry after another arose, and it was only in the year 1914 that conditions became satisfactory.

In our issue of June last we mentioned that manganese deposits in the Wassaw district are being developed by the Fanti Consolidated, conjointly with the prospective users, the Darwen & Mostyn Iron Co. It is now announced that shipments commenced in September last, and that up to December 1, 3133 tons had been despatched by sea from the port of Seccondee. The output will shortly be at the rate of 5000 tons per month. The profit on these shipments to shareholders depends largely on the cost of freight on the West African railway and by sea. Negotiations with regard to this cost are in hand between the producers and the Minister of Munitions.

The Jantar company is one of the operators in Nigeria that present their yearly accounts promptly and in this way constitute a contrast to the dilatory companies to which we referred in a recent issue. The receipts from actual sales during the year ended September 30 are reported, with the carry-forward of unsold concentrate from the previous year deducted, and the estimated value of the concentrate unsold at the end of the year added. In this way we gain an idea of the position of affairs with the least delay. The output increased from 162 to 261 tons and the working cost has been reduced from £87 to £76 per ton.

Australasia.—The labour conditions become threatening occasionally in Australia. The latest trouble has been at the coal mines in New South Wales, where a strike prevailed for some time. The position grew so serious that companies at Broken Hill and other mining centres had to close down or had to contemplate the immediate necessity for so doing. The State Government satisfied the miners eventually, and coal-winning was resumed. The result may possibly be that State control will be instituted.

The latest messages with regard to the Australian Government's taxation proposals indicate that the new Treasurer is abating the oppressive spirit of his predecessor. The most important concession is that mining companies are to be exempted from the war-time profits tax. This is a big change from the previous proposal to take the whole of the excess profits. Other companies are to pay 50% war-time profits tax for the first year and 75% for the second year. At the same time, ordinary income tax is to be increased.

A year ago the deepest level, 1270 ft., at Broken Hill South was not developing well. The half-yearly report recently received shows that exploration by bore-hole has given a more promising complexion to matters, for thicknesses 20, 24, 40, and 143 ft. of average ore have been disclosed in four bores. In the slime flotation plant the lead concentrate produced averages 61·8% lead, 10·6% zinc, and 45·4 oz. silver, leaving a zinc residue averaging 12·7% zinc, 1·5% lead, and 0·8 oz. silver. The zinc section had not been completed when the above figures were published.

The Oroya Links has never been one of the successful Kalgoorlie companies, though small dividends have been paid at various times. At the last general meeting, held in July last, the directors foreshadowed a possible suspension of operations, owing partly to the exhaustion of ore at all the mines except the Eclipse, and partly to the increased costs. It was no surprise therefore when, last month, the directors decided to close down until mining and labour conditions improve. In the meantime additional facilities are being given to tributers.

Following on the announcement, in our October issue, of the Victorian Government's intention to investigate the geology of the Bendigo district comes the news that forty companies in the central area are to be amalgamated with a central administration.

The Lloyd Copper Co. is an English venture in Australia that has had an undue share of bad luck. We recorded recently that efforts to re-start operations, and so take advantage of the high price of copper, had proved abortive. Since then the smelting plant has been sold to the Mouramba company. Attempts were also made to induce shareholders to subscribe funds to liquidate the debt owing to the Australian Bank of Commerce and to put the mine in productive shape. The efforts failed, and the bank foreclosed and sold the property, the purchasers being Messrs. Cameron & Sutherland.

We referred briefly last month to the impending expansion of operations at the Mount Elliott. Since then detailed accounts of the prospects have been issued in this country. At the orginal mine, the Elliott, the high-grade ore is exhausted, except that left in the necessary pillars, but large amounts of concentrating ore remain. At the Consols there is a fair reserve of 7% ore, and a large tonnage of low-grade ore. The bulk of the ore to be treated during the next year or two, however, will be drawn from the Dobbin group, owned by a company the control of which was secured by the Mount Elliott not long ago. The railway to the Dobbin is practically completed. Another important asset is the Mount Oxide group of mines, recently acquired by the issue of shares. These mines are at present a long way from a railway, and negotiations are in hand with the Queensland Government with a view to the provision of some means of communication. The deposits are extensive and promise to become big producers. The reorganized smelter at Elliott will start in March, and the output is estimated by Mr. W. H. Corbould at about 700 tons of copper per month. The refinery has been built at Bowen, on the coast, not far from a new coal-field. The refining will not be done electrolytically but by fire. The gold and silver contents are not high, and they will be recovered from bottoms as in the old Swansea process. The output for 1917 has been sold to the Ministry of Munitions at a price equivalent to £120 per ton c.i.f. London.

Canada.—A new oilfield is being developed by the Vacuum Gas & Oil Co. in the vicinity of Thamesville, about 50 miles west of London, Ontario. The company has secured control of 800 acres of oil-bearing land in this neighbourhood, and began active operations about five months ago. It has now seven producing wells, and several others in different stages of development. A gas engine which supplies the pumping power has a capacity for operating 25 wells. These will constitute the first unit. The company intends to establish two other units, bringing the total number of operating wells up to 100. The oil is shipped for refining to the Imperial Oil Company's refinery at Sarnia, Ontario. The activities of the Vacuum Gas & Oil are not confined to this area, as it has large holdings in the Essex and Kent oilfields and elsewhere, and has just obtained a flow of natural gas in the Tillsonburg area. The oil of the Thamesville wells is claimed to be of specially high-grade quality.

The refinery works of the International Nickel Company at Port Colborne, on Lake Erie, are now being built. The capacity will be from 10,000 to 15,000 tons per year. The smelting plant at Sudbury will be enlarged so as to increase the production from 30,000 tons to between 40,000 and 45,000 tons. The amount of ore treated at present is about 850,000 tons averaging 4½% nickel and 2¼% copper.

India.—Developments at the Champion Reef mine continue to be disappointing, especially in the deep levels in the Garland and Carmichael sections. The reserve of ore has been depleted to the extent of 119,024 tons during the past year, now standing at 375,991 tons. As recorded in our July issue, rock-bursts (formerly called air-blasts) had become so common that part of the workings were closed while a system of closer filling was inaugurated. The profit distributed during the past year amounted to £104,000 from a yield of gold worth £497,329, extracted from 194,311 tons of ore, as compared with £147,333, £545,338, and 211,368 tons the year before. The indications are that the monthly returns will show a further diminution during the next few months. From the commencement of operations in 1892, £4,408,966 has been paid in dividends out of a yield worth £12,190,117.

Cornwall.—We refer in our editorial columns to the approaching registration of the Cornish Chamber of Mines. In our Discussion column, Mr. W. H. Trewartha-James announces that the negotiations between the Institution of Mining and Metallurgy and the Royal Cornwall Polytechnic Society have been satisfactorily concluded, and that the joint committee on research has already started work. The Institution had previously started research some months ago. We shall be able to give details of some of this work before long.

The Porkellis Tin Mines Co. has been formed by the Rayfield Cornwall company, of which Mr. Oliver Wethered is the leading spirit, to acquire the Basset & Grylls mine near Wendron. Some work was done here a few years ago at the recommendation of Mr. R. Arthur Thomas. The reports show that the lodes are of fairly high grade, and the venture is distinctly promising.

Russia.—The Irtysh Corporation has presented its first annual report, and with it is issued a statement by the engineers describing the progress made up to date. At the Ridder mine, the sixth level from the Gregorievski shaft is being developed; the shaft has been sunk to a seventh level, and cross-cutting to the lode is in hand. The North shaft, 800 ft. away, has been sunk 90 ft. A third shaft to the south is to be started. The temporary concentration plant treated 13,000 tons of high-grade ore up to October 1, and produced 5100 tons of zinc concentrate and 1600 tons of lead concentrate. This plant will be at work all next year, and in the meantime a new concentrator with a capacity of 200,000 tons per year is to be erected. At the zinc smelter, the first distilling furnace was put into commission in August last, and a second is expected to start before the end of this year. Four more should be ready during 1917, and the intention is to build 20 eventually. The first lead blast-furnace will be ready early in 1917, and the second during the summer. A lead refinery and a bullion parting plant is in course of erection. Little exploration has been done at the mine lately, and the reserve remains as follows: high-grade ore 945,000 tons averaging 18·1% lead, 31·2% zinc, 1·5% copper, 9·4 dwt. gold, and 9·7 oz. silver; concentrating ore 2,229,000 tons averaging 3·5% lead, 6·7% zinc, 0·5% copper, 14·2 dwt. gold, and 1·7 oz. silver. At the Ekibastus coal mine, where the smelters are situated, the development is done by sinking inclines from the outcrop. Machine cutters are largely used, and their number will be increased. The present output of coal is 75,000 tons per year. The coke-oven installation is being extended, and by the end of the year the production will be 400 tons per month.

A year ago the bonne bouche for Tanalyk shareholders was the announcement of a discovery of rich gold ore at Tuba. This property has already been developed into a mine, and is serving to increase the gold content of the blister copper. Already 23,000 tons of ore has been developed, averaging 68 dwt. gold and 20 oz. silver per ton, and 1% copper, while 25,000 tons is estimated as extensions, averaging 35 dwt. gold and 30 oz. silver. It has been decided to treat this ore by amalgamation instead of sending it to the smelter, and the plant for this purpose will be ready shortly. A recovery of 60% is expected. The further treatment of the ore will be investigated after the plant is at work; probably it will be sent to the smelter.

The Troitzk gold mine was one of the bad Russian eggs introduced in London ten years ago by Mr. Heyman Orkin through the Siberian Proprietary. The other gold mine introduced at the same time, the Orsk, was soon abandoned, and the Orsk company thereupon acquired the placer property at the other end of Siberia. On the other hand the Troitzk struggled on bravely under the adversities arising from low-grade and irregular ores. Finally it was acknowledged that no headway could be made, and the property has now been sold locally for 250,000 roubles, the larger part of which will be distributable among shareholders.

Spain.—The Huelva Copper & Sulphur Co. is one of the few copper companies working in the south of Spain that give details in their reports. Under the management of Mr. H. F. Collins the ill-luck of former years has been retrieved, and profits have been made during the past two years, but unfortunately these profits have had to be applied to writing off for depreciation of plant. Mr. Collins introduced smelting for the greater part of the ores, instead of selling them for copper and sulphur content. During the year ended June 30 last, 71,071 tons of ore was raised, and of this 57,446 tons was smelted, the remainder going to the leaching floors. The output of copper for the year was 1707 tons, as compared with 1222 tons the year before. The company enjoyed the benefit of the increased price of copper, but on the other hand had to pay from 50 to 100% more for coal and coke supplies. The smelting operations having been placed on a sound basis, the directors are now turning their attention to further exploration underground, with the object of increasing the ore reserves, which are at present not sufficiently far ahead of the smelter requirements. The leaching floors are to be extended, in order that more of the low-grade ore shall be treated. An electrolytic refinery is to be erected. Mr. Collins recently resigned the management, and is now consulting engineer. Leon Delafosse succeeds him as manager.

Mexico.—In our last issue we recorded that Carranza had ordered mining companies to resume operations under heavy penalties for disobeying. The El Oro mine was the only property in the El Oro district that was not being worked at the time the decree was issued, and resumption was only agreed to under protest. At the meeting of shareholders held on the 6th inst. the chairman, Mr. R. T. Bayliss, reviewed the conditions now prevalent in Mexico. The accounts for the year ended June 30 ought to have been presented at this meeting, but they have not arrived here.

Nicaragua.—The Central American Mines company is to be reconstructed. It was formed in 1910 as the Oroya Leonesa, and works a gold mine in Nicaragua. In 1913 additional funds had to be provided owing to difficulties arising from revolutions and shortness of labour. The present troubles were caused by flooding of the workings and consequent damage to the shaft and levels. Until more ore is developed and No. 3 level opened out extensively, the cost of milling will be too high, so extraction of ore is being suspended in the meantime. Lake View & Oroya Exploration is the largest individual shareholder, besides being a debenture holder and a creditor for unsecured loans. This company agrees to provide additional funds in the reconstruction and to capitalize its loan.

Brazil.—The St. John del Rey Company announces that the orebody at the Morro Velho mine has been cut on the 20th horizon at 5826 ft. vertically below the outcrop, and that drifts have followed the lode for 450 ft. The ore compares favourably with that in the levels above.

BUCKET-DREDGING FOR TIN

IN THE

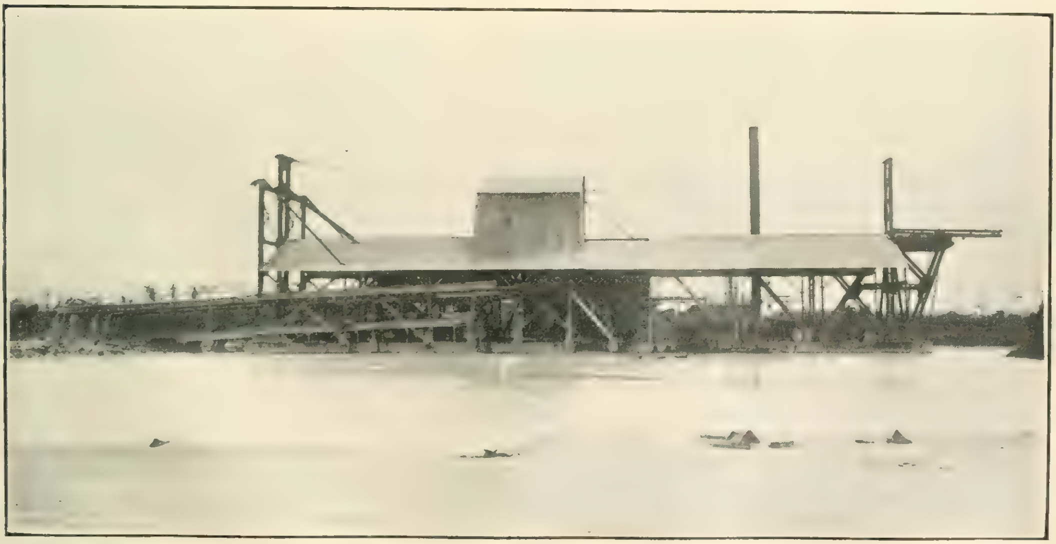
FEDERATED MALAY STATES.

By HARRY D. GRIFFITHS, M.Inst.M.M., M.Inst.C.E.

Chapter I.—The Beginnings of Bucket-Dredging for Tin—Present Dredging Operations—Local Conditions for Bucket-Dredging—Testing a Property—Methods of Working—Method of Taking Cuts—Ascertaining Percentage of Extraction—Measuring Up—Ore Dressing.

INTRODUCTORY.—A wide interest has always been taken in the tin-mining industry, and especially in the working of the mines of the Federated Malay States. Of late years the possibility of working by new methods the large extent of ground which had previously been worked-out by the open-cast system, or which was of so low a value as to be unremunerative, has been investigated. Led by the results achieved in Siam, bucket-dredging was instituted in the Malay States in 1912, and it has so far been so successful as to give hopes of further extensive developments. Literature on this subject in the Malay States is scarce, and it is thought that a description of the new industry will prove interesting. The author, who has been associated with it from the outset, made, on a recent visit, careful investigations, the results of which are now presented. These articles have no pretension to be a scientific work. They contain a plain statement of facts, free from controversial matters and within the grasp of any layman. The object is to draw the attention of investors who, after the war, will be looking for a chance of rebuilding a financial prosperity which of late has been inactive. Mining engineers will also find some interest in reading the part relating to the dredges themselves. The author acknowledges the help given him, during his investigations, by the directors and managers of the companies concerned and the Federated Malay States Mining Department, to whom he is indebted for the figures from which the tables have been compiled, and for permission to visit all the dredges at work.

PRODUCTION OF TIN.—For many years past the Federated Malay States have been known as the greatest alluvial tinfield in the world, producing over 40% of the world's output, as shown by the following table:



NO. 3 DREDGE OF THE MALAYAN TIN DREDGING CO., LTD.; DESIGNED BY AND ERECTED UNDER THE SUPERVISION OF MESSRS. F. W. PAYNE & CO.

Year	World's production of tin in tons	F.M.S. production in tons	%
1910	103,500	—	—
1911	110,320	44,148	40·01
1912	113,750	48,420	42·56
1913	115,000	50,127	43·58
1914	116,500	49,042	42·09
1915	112,281	46,766	41·64

AVERAGE PRICES.—The average price of tin in the Federated Malay States is given in the following table, the units being the picul (133⅓ lb.) and the Straits dollar (2s. 4d.).

Year	Dollars per Picul	Year	Dollars per Picul
1902	80·0	1909	69·5
1903	83·5	1910	78·0
1904	77·3	1911	94·5
1905	80·5	1912	104·0
1906	89·7	1913	99·0
1907	86·0	1914	73·5
1908	67·0	1915	78·5

When the price is given in dollars per picul and it is desired to obtain the approximate value in pounds per ton, multiply the price in dollars by 2. Thus $100 per picul equals £200 per ton. This is approximate only, the correct multiplier being 1·96.

OLDER METHODS OF WINNING.— The ore has been mostly obtained from alluvial deposits, which seldom attain a depth exceeding 100ft., and which have generally been worked by the open-cast system. The deep deposits, say beyond 60ft., have been partly worked by primitive and wasteful methods of underground mining, but the tendency during the last few years has been to abandon this class of work in favour of open-cast when the conditions prevailing were favourable. The deep deposits are generally exceptional, expensive to work, and involve a large outlay of capital before profitable results can be obtained, and for this reason are not much favoured by the Chinese miner.

Concerning the shallower deposits the old Chinese method of working has in many cases been discarded in favour of hydraulicking and elevating the ground by means of centrifugal pumps. This method had many advantages which permitted the working at a profit of ground which under old conditions would have been unprofitable, and it is likely to prevail still where the conditions essential for bucket-dredging are absent, but where water under natural pressure is available.

BEGINNINGS OF BUCKET-DREDGING.—A very large area in the valleys in Perak consists of almost perfectly flat lands, only a very few feet above the level of the water courses and with a depth seldom exceeding 60 ft. The soil is of alluvial origin, consisting of a large portion of barren earth and sands forming the overburden, and followed down to bedrock by the wash which carries the cassiterite. The nature of the wash varies according to locality, and may consist of coarse sands, sandy clays, or tough clays carrying boulders and enclosures.

The possibility of working these deposits by bucket-dredges was recognized many years ago, but the method was not given a trial until the year 1912, when the Malayan Tin Dredging Co. Ltd. started the first bucket-dredge in the Federated Malay States.

The Tronoh Mines had already started a small dredge designed only for the treatment of old accumulated tailing, and though as such it did not prove a success, owing to the conditions of work having become very onerous, and to the dredge not being provided with a stacker, it nevertheless established the fact that such a machine could dig, elevate, and treat ground at a less cost than any other method which had hitherto been tried. Although of small capacity (5 cu. ft. buckets), and working under most difficult conditions, it proved capable of doing its work at a cost of 11 cents or 3·08 pence per cubic yard, as shown by its record of the month of December 1912, which is as follows:

Working days	21
Working hours	252
Stoppages, hours	115¾
Percentage of stoppages	45·9%
Yardage treated	13,500
,, ,, per hour	99·1
COSTS:	
Native wages	$605·70
Salaries	485·74
Fuel	220·16
Stores	56·86
Repairs	34·96
Sundries	56·48
Percentage of general expenses	50·00
Total	$1509·90

The Malay dollar = 2s. 4d.

From its very start the Malayan Tin dredge, in spite of many difficulties in the shape of untrained labour, weakness of certain working parts, stoppages for adjustments and alterations, etc., proved itself capable of working within the costs which had been calculated upon, and which were to make the property a profitable undertaking. (The writer at the time calculated the cost at 4½d. per cubic yard).

PRESENT DREDGING OPERATIONS. — Since that time the possibilities of bucket-dredging have been more closely investigated, and that branch of industry has made rapid progress, as shown by the fact that the following dredges are now at work in the Federated Malay States and are all yielding a fair profit:

Name of Company	Operating in	No. of Dredges at work
Malayan Tin Dredging Co	Kinta Valley	4
Tronoh Mines, Ltd.	,,	2
Ipoh Tin Dredging Co ...	,,	1
Chenderiang Tin Dredging Co.	,,	1
Kamunting Tin Dredging Co.	Taiping District	1
*Kampong Kamunting Co.	,,	2
Tekka Taiping Ltd.	,,	1
	Total...............	12

The following dredges are now ordered or in course of erection:

*Larut Tin Dredging Co...	Taiping District	1
*Assam Kumbang Co.......	,,	1
*Trong Tin Dredging Co..		1
*Bentong Tin Dredging Co	Kelantan	1

*These companies are Australians, and their dredges have been or are being designed and constructed in Australia

During the year 1915 the above dredges produced 37,375 piculs (=2224 tons) of cassiterite or 4·78% of the total production of the Federated Malay States. This result was obtained from the treatment of 5,977,829 cubic yards or at a return of 0·62 catties of tin concentrate (0·83 lb.) per cubic yard. (See Table I).

During the first four months of 1916 the bucket dredges produced 23,195 piculs (=1380 tons) or 9½% of the total of the Federated Malay States. The proportion of the total output produced by bucket dredges is now therefore double that of 1915, and it will be considerably increased in the near future, with the starting of the new dredges now under construction.

The area occupied by the bucket-dredging companies actually producing is about 6346 acres as compared to a total of 288,109 acres alienated for mining in the Federated Malay States. Vast tracts of mining and other lands where the conditions are suitable for bucket-dredging still exist, and when it is considered that mining ground which has been worked and re-worked in times past by Chinese methods is now being treated profitably by bucket-dredging, it follows that provided the necessary capital be forthcoming, the possibilities of this method of work are unlimited, and it is fair to reckon that within a few years it will be responsible for 50% of the output of the Federated Malay States.

It is unfortunate that in the past the Government of the Federated Malay States should have been induced to grant, under agricultural leases, large tracts of ground where tin exists in profitable quantities for bucket-dredging, but it is fair to state that, at that time, the tin contents were considered so low as to be unworkable by any method then known. As a large portion of such lands has now been planted with rubber and is yielding an important revenue, it must be considered as a loss to the mining industry and to the States.

Under certain guarantees and conditions, the Government has the power, through the State Residents, of converting agricultural leases into mining leases, on payment of a moderate premium, and no difficulty in that respect has yet been encountered.

LOCAL CONDITIONS FOR BUCKET-DREDGING.—Ideal conditions for dredging have so far been the exception in the Federated Malay States, although they would appear to exist in certain districts. The drawbacks may be enumerated as follows:

(a) *Nature of Bedrock.*—In the Kinta valley the bedrock consists mostly of limestone and is very irregular. The limestone shows many projections or pinnacles which often rise to within a few feet of the surface. The best tin wash lies generally upon these pinnacles and in the pockets between them. It is therefore easily understood that when the pinnacles are close together a dredge is unable to extract the ground lying in the intervening spaces.

TABLE I.—PRODUCTION FROM BUCKET DREDGES IN 1915.

Company	No. of Dredges	Time Working	Working Hours	Cub. Yards Excavated	Piculs produced	Catties per Cub. Yard
Malayan T.D., Ltd.	4	3–12 months 1–3 ,,	—	2,412,860	11,966	0·49
Tronoh Mines, Ltd.	1	12 ,,	4,732½	790,869	4,391	0·55
Ipoh T.D., Ltd. ,....................	1	4 ,,	1,857	248,800	1,538	0·62
Kamunting T.D., Ltd.	1	9½ ,,	—	929,000	8,966	0·96
Kampong Kamunting, Ltd........	2	1–9½ ,, 1–1 ,,	—	640,000	4,768	0·79
Chenderiang T.D., Ltd............	1	8½ ,,	—	754,800	4,248	0·56
Tekka-Taiping, Ltd.	1	10 weeks	—	201,500	1,498	0·74
Total and average......				5,977,892	37,375	0·62

1 Picul = 133⅓ lb.; 1 ton = 16·8 Piculs; 1 Catty = 1⅓ lb.

The average depth of the deposit and its cubic contents having been calculated from a series of test bores which are continued down to bedrock, it is evident that an allowance must be made for ground which will be unrecoverable by a bucket dredge, and also for the probable actual returns of ore per cubic yard. The tin wash is generally in close proximity to the contours of the bedrock, and unless all the ground can be scooped out, the returns will not tally with the average value indicated by the bores. The sketch in Fig. 1 will illustrate this statement. In the Taiping valley, the bottom is flat and even and composed of "kong," or hard clay probably derived from the decomposition of the granites. The clay is very distinct from the patches of tin-bearing boulder-clay which occasionally lie immediately above it. This forms an ideal bottom for dredging, and the adverse conditions of a limestone bottom are entirely absent. The results obtained in practice will be enumerated later.

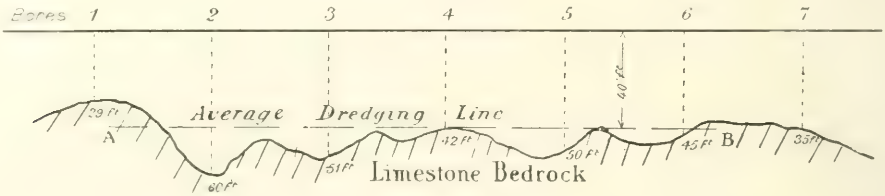


FIG. 1. DIAGRAMMATIC SECTION OF THE DREDGING GROUND.

(b) *Nature of Deposit.*—The tin deposit may consist of loose sand, sandy clay, soft boulder-clay, tough boulder-clay, or a combination of all. In the Kinta valley, the average deposit consists mostly of loose sand carrying very little tin in a fine form, followed by streaks of richer sands, and then soft clay carrying angular, sub-angular, and rounded enclosures of small size and rich in ore. Stretches and masses of tough and hard clays, practically free from boulders or tin, are occasionally met with. As all this class of ground has to be handled, it follows that the conditions vary greatly, and that in one spot a dredge may be called upon to act only as a lifting machine, whereas a few yards away another may have arduous digging work to perform. In the Taiping valley, some fairly light tin-bearing clay is found beneath the overburden sands and above the "kong." This part of Perak has been very extensively worked by the Chinese miners during the last eighty years, and although virgin ground undoubtedly exists, attention has been mostly devoted to the acquisition and working of this so-called "worked out" ground. The Chinese methods of the past have been so inefficient in extraction that the rejected sands and tailings are sufficiently rich to be worked profitably by bucket-dredging now. The ground, having been worked over, is of a very loose nature, and virgin tin-bearing clay is only found at the spots which separated the different "lombongs" or mine holes, or in such spots as were then considered not rich enough to open out. The available area of this class of ground in that district for dredging is enormous.

(c) *Obstructions.*—These consist chiefly of tree stumps and roots, and boulders. The former may be encountered anywhere and near the surface, but as a rule they do not cause any great inconvenience, as they are easily dealt with if the dredge is provided with a special crane fixed on or near the forward gantry. The boulders vary in size and quantity and occur mostly in ground lying close to the foot of the present hills where the tin deposit would partake more of the nature of a talus.

(d) *High Ground.*—Even in the flat country some portions rise above the general surface, and may become a hindrance to bucket-dredging when they exceed 7 or 8 ft. above water level, unless the water can be raised in the paddock accordingly. These eminences are, however, not plentiful and they often represent the dumps of former mines which are well worth working. The height above water level of the outlet of the riffles of a dredge seldom exceeds 10 ft., and it is only when treating sands fairly free from clay that the tailing can be packed at a height of 4 or 5 ft. above the water in the paddock. If there is a good available fall in the supply of water for the paddock, the level of the latter can generally be raised sufficiently to work the high ground comfortably. The water supply is generally ample and in this respect no trouble has occurred to any of the dredges at work.

(e) *Effluent Water.*—Owing to the rapid silting up of the water courses and rivers, the

Government of the Federated Malay States has for some years past compelled the mines to settle their effluent water so that it should not contain more than a certain quantity of solid matter. In spite of this rule being somewhat rigidly enforced, the silting up still goes on increasingly, although mining operations have not expanded proportionately. The blame cannot therefore be put entirely on the mining industry. The plantations are undoubtedly partly responsible for the evil, especially those that are situated on rising ground. The undergrowth having been entirely removed, the denudation of the soil during the heavy rains is more rapid than previously, and the storm waters, instead of flowing off quite clearly, now carry large quantities of fine sand which contributes more to the silting up of water courses than the slime of the mines. This is very apparent in those water courses which drain entirely agricultural districts on the slopes of the hills, and which ran quite clear before planting was undertaken but now silt up rapidly. The Government is well aware of this fact, and will not, in the future, be inclined to take drastic measures in the case of mine exploitations. So far as dredging experience is concerned, the paddocks are generally of a large area, giving plenty of opportunity for a settlement of the slime in the paddock, and the effluent water is actually much cleaner than any that used to flow from the mines a few years ago. This point should not therefore be considered as a serious deterrent to bucket-dredging.

It follows from the above remarks that local conditions vary and that a uniform design of dredge is not possible or advisable. A dredge working successfully on loose sandy soil would give great trouble and would be much less efficient if working on clayey ground. So far the main design of the most successful dredge has been followed, and in many cases it has not proved as successful as anticipated owing to the conditions of the deposit being variable. At the present time this point is considered of the utmost importance, and acquired experience permits of special designs to meet the conditions revealed either by the boring of the properties or the working of some property in the vicinity.

RECOVERIES BY DREDGING.—In the case of a limestone bottom with pinnacles it is impossible to remove the whole bulk of the ground that has been indicated by the boreholes. As to what average percentage of extraction may be expected from such properties it is difficult to say, as experience has been so far very limited. Of the two properties now working that class of ground in the Kinta valley, it is reckoned that the Malayan Tin Co's dredges are capable of removing about 85% of the total bulk indicated by the bores, and the Ipoh Tin dredge 80%. The work on the former being done on a large scale with four powerful and well designed machines spread over a large area, its result must necessarily be accepted as the nearest approximation.

The recovery of the deep ground between pinnacles which is now lost, has given deep thought to those concerned, and it is believed that some unsuccessful attempts have been made. The most important one is reported to have consisted of a powerful suction pump fixed on the dredge, the suction pipe of which could be lowered into the deep ground and was fitted with a revolving cutter. The main difficulties were that the ground being clayey and carrying boulders, the cutter broke or wore away rapidly, a large quantity of the cut material was not sucked up, and the cost of the work was disproportionate to the results obtained. When the ground consisted of sand, the churning-up due to the cutter, which it was still essential to use, caused a partial concentration of the coarser cassiterite pieces which fell to the bottom and failed to be sucked up the pipe.

A system of steam crabs placed on separate barges was also considered, and although it was not given a trial, it was reckoned that the ground would be too tough to be thus tackled, and that even if it could be grabbed and lifted, it would necessitate a puddling installation to disintegrate it. The cost of such a trial installation would have been too great for any of the operating companies to tackle, and its results too doubtful. The idea has not yet been finally abandoned, and it may eventually be revived, inasmuch as the deep ground is almost invariably the richest, and one which could easily stand a much higher working cost than ordinary dredging ground. In the meantime the deep ungetatable ground is being abandoned *in situ*, covered over almost immediately by the dredge tailing, and becomes a total loss to the industry and to the State.

In the Taiping valley where the bottom is even no such loss can occur, and as the actual dredging has to penetrate a certain depth into the "kong" in order to secure the cassiterite which generally adheres to its surface, the amount of ground extracted per acre may be slightly greater than that indicated by the prospecting bores.

The unavoidable loss of the ground lying in the pockets of an uneven bottom may have a serious effect on the quantity of tin recoverable per cubic yard as compared to that indicated by the average of the bores. This has already been shown clearly in Fig. 1, and it points to the necessity of carefully studying the results of the boring, reducing certain bores to what can be reckoned as the maximum dredging depth, and from these deducing what the actual recovery is likely to be. Even in doing so, a man of great experience may not arrive at a close approximation, owing to the cassiterite not being anything like evenly distributed in the deposit.

In the case of the Malayan Tin Dredging Co. the results of the year ended June 30, 1915, showed that a recovery per cubic yard of about 65% of the average indicated by all the bore-holes put down previous to the flotation of the company was obtained. Since that time, however, with work on a more extensive scale the percentage of extraction appears to have very greatly increased, and it is probably now between 80 and 85%.

With the Ipoh Tin Dredging the recovery is 78% of the value indicated by the bores covering the area worked out, but it must be said that the ground consists mostly of tough clay which can only be partly disintegrated in the screen, and which therefore does not yield all its mineral contents.

Where the deposit consists almost entirely of sand the recovery should approach that indicated by the bores. That is the case in several instances, as will be mentioned later in the article.

Testing a Property.—The value of a dredging proposition is determined by hand-boring the ground at regular intervals. Owing to the land being flat, low lying, and often water-logged, pitting is very seldom resorted to. The usual procedure of boring has already been described and it is not necessary to revert to it, unless it is to say that there is no hard and fast rule as regards the measuring of the bore-hole ground and the panning of its tin contents. The different methods employed are accurate enough provided the supervision as regards actual depths from which samples are obtained, the securing the whole samples, measuring and panning the same, etc., has been careful. The loss of tin in panning the samples varies according to individuals. From numerous and extensive tests undertaken by the writer during 1912 it would appear to be about 15% in the case of fine tin as found in dredging ground. Such a loss was found to be identical to that from well designed and carefully supervised riffles, so that under ordinary conditions the recovery should tally with that indicated by the sample taken. It is not essential that extreme care should be taken in panning samples in order to secure the very fine tin which no dredge tables could possibly recover.

In order to ascertain if a property contains tin "scout" boring, with one hole to every 8 or 10 acres, is undertaken. If the results approach remunerative value, further boring with holes placed from 2 to 3 chains apart may be put down, and it is reckoned that one bore to the acre is close and accurate enough for all practical purposes.

As far as is known, none of the dredges at work in the Federated Malay States has returned the values indicated by the bores, although some instances have occurred when they have temporarily exceeded them. In the Taiping district, the No. 1 dredge of the Kampong Kamunting Tin Dredging Ltd. during the 6 months ended August 31, 1915, returned 81% of the bore-hole values, and for the six months ended February 28, 1916, 85·7%. Future work is reckoned to yield 90% and during one month recently a recovery of over 120% was obtained. In the same district the Tekka Taiping dredge returned 71% in January 1916, 76% in February, 84% in March, 81% in April, 92·6% in May, and 111% in June, or an average over six months of about 86%. In the Kinta valley the Ipoh Tin Dredging returned 83% for the same period. Although these particulars are not generally published by the companies and are difficult to obtain for obvious reasons, the writer considers it is fair to assume an average recovery of 85% of the bore-hole values for ground fairly free from clays as usually found in Taiping district, and 80% for other grounds.

Reckoning upon the latter low extraction, and taking the total cost of working at 15 cents or 4·20d. per cubic yard (this will be shown presently to be well within safe limits), a property showing an average bore value of ½ cattie only, should yield by bucket-dredging with tin at $80 per picul (£156. 18s. 0d. per ton), a profit of 5·8 cents per cubic yard, and with tin at $65 per picul (£127. 8s. 0d. per ton) a profit of 1·9 cents, as shown by the following calculations:

Taking the average value of bores = 0·5 catties; the extraction 80% of bores = 0·4 catties; and the all round cost per cubic yard 15 cents (4·2d.):

With (*a*) Tin at $80; net value of concentrates $52

0·4 × 0·52 ...... = 20·8 cents
Less costs......... = 15 ,,
Net profit....... = 5·8 ,,

(For 1915 the total costs, including depreciation, head office, etc., of the Malayan Tin and the Ipoh Tin were respectively 13·01 and 14·11 cents per cubic yard).

With (*b*) Tin at $70; net value of concentrates $45·50

0·4 × 0·455 ..... = 18·2 cents
Less costs......... = 15·0 ,,
Net profit....... = 3·2 ,,

With (*c*) Tin at $65; net value of concentrates $42·25

0·4 × 0·4225.... = 16·9 cents
Less costs......... = 15·0 ,,
Net profit ...... = 1·9 ,,

If the average of the bores is 0·75 catties the profits will be:

(*a*)........... 16·2 cents or 4·536d.
(*b*)........... 12·3 ,, ,, 3·444d.
(*c*)........... 10·3 ,, ,, 2·884d.

During the first 6 months of 1916, the Ipoh dredge on a return of 0·56 catties per cubic yard made a profit of £8939, and a return of 0·21 catties (4·5 oz.) per yard covered the cost of working. Another small dredge in the vicinity is reported to cover its working costs on a yield of 0·224 catties (4·77 oz.) per yard.

METHODS OF WORKING,—The method of working dredging ground is of the simplest description. A paddock of dimensions sufficient to allow the easy evolutions of the dredge is opened out to a depth providing a margin for flotation. The dredge is built either on the edge of the paddock, from where it is launched sideways from slips, or else it is built on a ledge in the paddock, some 12 ft. below the water level, and when ready for floating, water is allowed to fill up to its level, and no launching is required. The width of the paddock must be some 300 ft. or more to give plenty of clearance at each end when the dredge is swung round. The floating method, if circumstances permit, has many advantages over the launching method, as it obviously eliminates possible mishaps and the lifting up of a large quantity of material; it is cheaper in labour and accessories and it is more generally favoured. When actual dredging begins it is advisable, in order to provide space for the tailing, to dump the first tailing well over the bank at the stern end, and prevent any from returning into the paddock until the first cut has attained the length which has been ascribed to it. It may be necessary in order to achieve this result to bank up the edge with sand-filled sacks, and to cut channels to carry the fines well away. When the dredge begins its second cut on its way back, the tailing is allowed to fall into the paddock over the worked-out ground, where it packs and forms its own slope. It is found that, if the first cut is judiciously taken and some care has been taken to carry

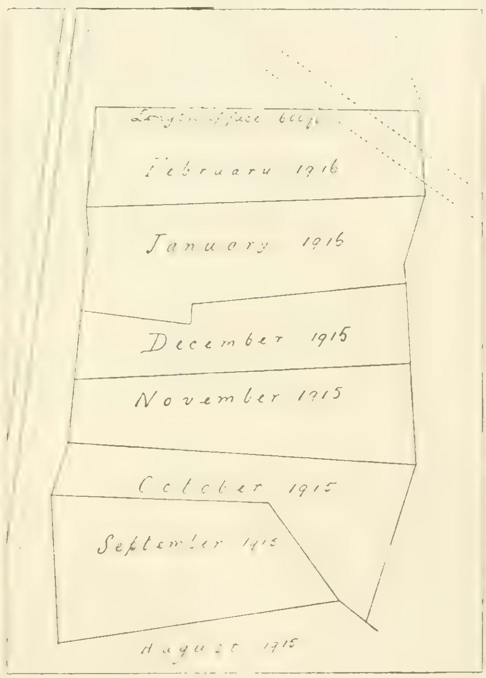


FIG. 2. MONTHLY CUTS AT THE KAMPONG KAMUNTING.

the first tailing well away, subsequent work will give no trouble, and that the slope of the tailing will not foul the stern end of the barge.

The length of the paddock for the first cut is fixed according to the shape of the ground and the system which has been devised to work it, and is necessarily a variable quantity. It is generally, however, found advisable to have as great a length as possible, with a straight face, and some paddocks attain as much as ten chains. Figures 2 and 3 show plans of the monthly cuts in the case of the Kampong Kamunting and the Ipoh. The Tronoh dredge cut has a length of about 600 ft., and at the Malayan Tin the cuts vary from 400 to 500 ft.

With a long cut and working face, the clean water supply is brought in as near as possible to the position of the dredge, and the outlets are placed near the ends of the cuts, thus giving as great a length as can be had for the settlement of the slime in the paddock. This is generally so well accomplished that the effluent water carries little solid matter; in fact, in the case of the Malayan Tin the effluent water is so clear and so much better than the incoming water that it can be directed to supply the paddocks of other dredges. Even in cases where a fair amount of clay is obtained, the slime appears to settle in a satisfactory manner. The quantity of water required to supply a paddock varies according to the nature of the ground worked. Although muddy water is undoubtedly of advantage in concentrating tin on riffles and acts better than clear water, a stage may be reached when the water being too thick will give trouble to pumps, pipes, condenser, etc., and will be detrimental to good concentration. A plentiful flow of clear water in the paddocks tends to carry slime away too quickly and before it has begun to settle. It is obvious that these points cannot be fixed theoretically, and that they can only be determined during actual work.

METHOD OF TAKING CUTS.—It is seldom that a property can be worked without resorting to benching at different depths. Cases exist, however, in the Taiping valley where worked-out ground consisting of very loose sands can be dredged by keeping the ladder on the "kong" bottom. The sands there form their own slope as their foot is removed. Where sandy clays or clays are encountered it becomes necessary to bench. This is generally started at a shallow depth from the surface, and the dredge is slowly moved along the face for a short distance until the first cut is accomplished; the ladder is then lowered and the dredge brought back to its original position in taking out a second bench, and so on until the bottom is reached and the dredging face is left sloping down at a fairly steep angle. The inroad of the benching into the face seldom exceeds 15 ft. before the dredge is moved to the next section, as otherwise it would involve too much swinging of the dredge and uneven distribution of the tailing at the back. The objects aimed at are convenience of work, keeping the dredge as near as possible at right angles to the faces, and the minimum moving of the forward lead anchorage. Uniformity of work is looked for by the dredge masters, and in this respect it is well attained in all cases in the Federated Malay States.

In digging and benching the buckets are carefully watched by the winchman, and they should come up full to their maximum capacity. If, however, tough clay is encountered, it may become necessary to take a very light cut in order not to overload the screen and allow the material to be as much disintegrated as possible in its passage through it.

A dredge master can generally attain the full capacity of his machine, but his work is necessarily regulated by the area of the screen, and of the concentrating tables, etc. If these are inadequate and cannot be increased, the capacity of the dredge is reduced by the speeding down of the buckets, in preference to reducing the quantity of stuff brought up by each bucket. A uniform flow of material through the screen and over the tables is advisable, as it tends to easy working, easy concentration, and a steady unfluctuating strain on all the parts. These results are not always obtained in the case of the older dredges where screen and table areas are too small, and a consequent loss is incurred from badly disintegrated material leaving the screen for the dump, and from the tables being too heavily laden for a steady and even flow. The overloading of the tables may also cause a temporary increase of their slopes and a detrimental rush of the stuff toward the outlet. These defects are now being remedied and will soon become things of the past. Nevertheless there still exists a tendency to devote more attention to obtaining a large monthly yardage, than to good concentration and high percentage of extraction. A large yardage has necessarily a great attraction, inasmuch as it enables a good show to be made in the direction of working costs per cubic yard, whereas the percentage of extraction is a difficult item to inquire into, and one which cannot be criticized by any but those in possession of full and accurate details.

The following example will show how a reduced turn-over resulting in an increased extraction may affect the profit. A dredge works at its full capacity of 100,000 cubic yards at a mine cost of \$8500, the cost per yard being then $8\frac{1}{2}$ cents. The returns are 0·65 catties per yard or 650 piculs, which at a tin price of \$80 represent a revenue of \$35,750 and a mine profit of \$27,250. If by reducing the capacity to 85,000 it is found that there is an increased extraction of 20%, the revenue will be \$36,465 and the mine profit \$715 more than in the first case although the working costs will be 10 cents.

ASCERTAINING PERCENTAGE OF EXTRACTION.—The difficulty of course lies in ascertaining exactly what the percentage of extraction is. Two methods of doing this are employed. The first consists of carefully boring and sampling the tailing after it has well settled, and comparing the value with the returns which have actually been obtained from the working. Thus, if over a certain period the ground has yielded 0·7 catties and the tailing therefrom assays 0·15, the percentage of extraction is reckoned at 83%. This method is generally that adopted by the Australian companies. The only element that offers uncertainty is the difficulty of panning accurately sands which carry only 0·15 catties or less per yard.

The second method, which is notably employed by the Tekka Taiping Co., is that of sampling, by means of a dip rod, every bucket as it comes up, thus obtaining directly the average value of the ground dug out and allowing of a comparison with the actual yield. This method may be slightly better than the first one, but neither can be considered as accurate. In tin deposits of the nature found in the Federated Malay States it is notably difficult, in fact almost impossible, owing to the uneven distribution of the cassiterite, and the varying nature of the material, to devise a method of sampling that would give accurate and positive results. The sampling rod cannot penetrate the whole of the ground contained in the bucket, nor can an even weight of sample be taken from each bucket. With hard clay it is difficult to take more than a spoonful.

When the 24 hours are completed, the samples may be treated in bulk, and passed through the lanchutes, concentrated in the ordinary way, and the concentrate cleaned up in a way similar to that employed for the product of the riffles. If this method is not adopted, the samples are well mixed up, quartered, etc., and several small samples are taken and panned in "dulangs," and the average value is obtained.

As regards costs, the two methods of sampling are about equal. In order to have the most accurate results in the assay of the tailing, the bores should not be placed more than 100 ft. apart and great care should be exercised in not taking up any of the "kong" bottom or any stuff which might have escaped being scooped up by the buckets. It is evident that in the case of an irregular bottom where patches and pockets of ore cannot be dredged up, such as prevails in the Kinta valley, the sampling of the deposited tailing is a matter of great uncertainty and difficulty, as there is always a chance of the drill penetrating some of the unworked ground and of the results being unreliable.

The automatic sampling of the tailing as it leaves the riffles and of the lumps leaving the screen offers such intricacies and difficulties as to render the method impracticable.

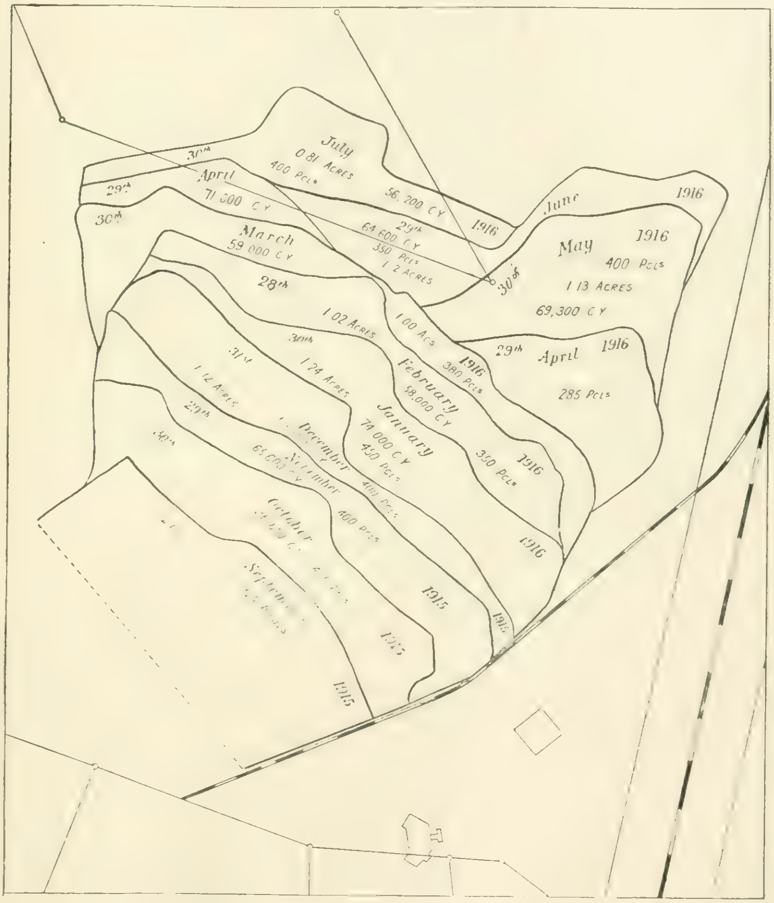


FIG. 3. MONTHLY CUTS AT IPOH TIN DREDGING CO.'S PROPERTY.

It follows therefore, from the foregoing remarks that anything like an accurate method of ascertaining the percentage of extraction cannot be obtained, but that if one particular method is steadily and evenly pursued comparative results of the working of a dredge at different times may be obtained. A comparison between the extraction on two properties where the methods of ascertaining them are dissimilar cannot obviously be made. All these difficulties are realized by the different managers, who are very chary to give such details thereon as they may possess.

MEASURING UP.—The amount of ground worked out by a dredge is measured monthly by professional surveyors working under contract. This is a simple operation when the bottom is even, and the dredge has dug at a practically uniform depth during the period. The contours of the area are plotted from offset measurements, and a simple multiplication by the depth gives the yardage. The results obtained are positive and reliable. But in the case of uneven bottoms where what is called the "average depth" of working for the month is taken, the results can only be approximate. The maximum depth being a constantly fluctuating measurement must be carefully noted daily, and at each change in order to obtain as fair an approximation as possible. The depth is seldom measured by rod or line, but is ascertained by the inclination of the ladder, with corresponding marks on the hull. The results of the survey are recorded and plotted, especially with reference to the area worked out.

METHOD OF CLEANING UP.—The cleaning up of the riffles is done in two ways. In one case the dredge is kept at work while the cleaning up takes place. The two outside riffles are cleaned up simultaneously, and when ready, the next are taken in hand, and the pulp is diverted to the first ones. The work is done in the day time only, by four Chinese to each riffle. This system has great advantages provided that: (*a*) the riffle area is ample for the yardage treated, (*b*) the dredge is in good working order and does not require daily overhauls or adjustments.

The second system consists in stopping the the dredge and turning all the riffle hands to cleaning up. For this work there are generally from 30 to 32 hands employed at change of shifts, when two full shifts of men or more can be present, and the time taken is from 2 to 3 hours. During that time, overhauling, oiling, and minor repairs can be effected. The loss of digging time involved is about 10½%, or 10,000 cubic yards per month in the case of a 10 cu. ft. dredge.

The advocates of both systems are about equally divided, but it is obvious that when rich ground is being worked and the dredge is in good repair, the continuous system is preferable as the greater yardage and returns more than compensate for the very small number of extra hands required. In the continuous system, specially experienced hands are employed who do the work more efficiently and with smaller losses than when all the ordinary riffle coolies are employed for the purpose. As every dredge is usually stopped for general overhauling and repairs monthly, whatever may be the method of cleaning up employed, it seems that the continuous system should be given the preference.

ORE DRESSING.—The rough concentrates obtained from the cleaning up of the riffles vary greatly in dry tin contents, from 15% to seldom more than 30%, according to impurities in the ore. These may consist of black sands, ilmenite, pyrite, etc., and in certain districts give a lot of trouble in the dressing. In order to ascertain roughly the exact daily production, each bucket of concentrate on arriving at the dressing shed from the dredge is sampled with a rod. The total sample is then carefully weighed and panned, and from it the percentage of clean dry tin is obtained.

The dressing up is generally done by Chinese tin-dressers on contract, at so much per picul of dry ore of a certain assay, with certain deductions in case of a lower assay-value, and bonus for increased quality. The majority of the ore is dressed to an assay-value of over 75%, the remainder seldom assaying less than 65%. In most cases the 75% material forms 85 to 95% of the total, but where black sands and ilmenite are plentiful, the proportion may be considerably less.

So far it has been only in one instance that impurities have seriously affected the tin-dressing, and that a magnetic separator has become advisable. The waste rejected consisted of black sands (iron oxides) and ilmenite (titaniferous iron) carrying 12% of tin oxide. It may be said, however, that this is an exceptional case, and that in the Kinta and Taiping valleys, concentration offers few obstacles. The product of the Ipoh Tin Dredging in 1915 consisted of 84·7% of ore assaying 75·2%, and 15·3% of second ore assaying 73·7%, whereas the waste from the dressing shed carries only traces of tin ore unrecoverable by any known methods. The average for the first 6 months in 1916 was 74·06%.

(To be continued).

THE GEOLOGY OF THE SHAMVA MINE

By DR. GEORGE S. CORSTORPHINE.

We reprint herewith a geological report on the Shamva gold mine, Rhodesia, made by Dr. Corstorphine for the Shamva Mines, Limited, and the Gold Fields Rhodesian Development Company, Limited. This report has been distributed among shareholders in the company. We republish it here in order that it shall reach technical and scientific readers. The examination was made with the object of ascertaining the chances of finding a continuation of the orebody below the fifth level.

THE deposit worked by the Shamva Mines, Limited, is situated on the northern slope and toward the western end of Shamva Hill, which extends some 1000 yards from east to west, and rises about 1000 ft. above Shamva railway station.

THE GENERAL GEOLOGY. — Many outcrops on the slopes and along the ridge of the hill yield evidence as to the general geology, while the extensive workings of the mine, extending 1000 ft. from east to west, and to a depth of 850 ft. down to the 5th level, give opportunity for more detailed information. The hill has no complex or intricate geological structure. The greater part consists of an even-grained, compact, greyish or whitish rock, belonging to the class of acid intrusives, a rock to which the name "micro-granite" may be applied. Cutting through this are several dikes and sills of much weathered basic igneous rock. These are exposed in the open-cut and in several of the adits at the western end of the hill. They play no important part either in the general geology of the hill or in relation to the ore deposit. A striking feature of the acid intrusive is its resemblance to a fine-grained, vertically-bedded quartzite, with occasional patches or layers of dark cherty pebbles. Though I found occasional difficulties, I accepted, during my visit to the mine, the prevailing diagnosis of the rock as a quartzite, and it was only after a careful study of a good many thin sections under the microscope that I was able to decide its true character.

In thin section the rock is seen to consist largely of a fine-grained, highly silicious matrix, and of coarser grains of quartz and crystals of several varieties of felspar, one of which is microcline, a characteristic mineral in the granites of Rhodesia. Dark mica is generally present, but much of it has been altered to chlorite, or even to a carbonate, an alteration which the felspars have in places, though rarely, also undergone. There is well-marked evidence of crushing in the rock, while secondary silicification and carbonatization have occurred throughout. The dark patches, which to the naked eye at first look like chert pebbles, are really portions of the rock where the minerals have crystallized out in minute particles; they are portions of the fined-grained matrix, and are much more numerous than appears on a cursory examination. They vary in size from quite minute specks up to pieces several inches in dimension. When carefully examined, even in the hand-specimen, they are seen to differ from ordinary pebbles, showing no sharp boundary between, but simply a gradual passage into the matrix of the rock. Moreover, they are all of the same type, which at once strikes one as a peculiarity on the assumption that they are patches of conglomerate.

There is some structural and mineralogical variation in the rock throughout its mass, though not to so great an extent as often prevails in rocks of this class. The northerly dip of the rock of Shamva Hill, conspicuous in the open working of the mine, is not that of bedding, but is due to the strong development of one of the sets of vertical joints. Weathering has, toward the exterior of the rock, accentuated the joints, but as they are followed downward or inward, away from the zone of percolation, they become less apparent and tend to disappear. On the 4th and 5th levels the rock is much more massive than higher up; while in the shaft down to the 6th level, and at that level, the appearance of bedding is no longer present. The simulation of bedding in acid intrusive rocks is not uncommon. It may be seen on the hill north of the Kimberley Reefs mine, Bindura, where the presence of a system of well-marked horizontal joints gives to a similar igneous rock the appearance of a horizontally bedded quartzite. In some European localities acid rocks, similar in character, can, owing to the fine jointing, be used as substitutes for roofing slate.

Adjacent to the north, though slightly separated by the valley through which the road passes, is a lower hill formed by a continuation of the same mass of igneous rock. It, too, forms an east and west ridge, while the outcrops have the same quartzitic appearance as those on the main hill. On its northern slope lies the Cymric mine, in which, though on a smaller scale, the same conditions prevail as at Shamva. Along the northern margin of this smaller hill are outcrops of dark, compact slate, which is well exposed in the cutting made to allow passage for the stream blocked up by the Shamva slime-dam. In that cutting there are veinlets, veins, and dikes, having an appearance as of quartzites interbedded in the slates, but which really are intrusions of granitic rock. Still further north the normal grey granite outcrops.

On its southern side Shamva Hill bounds a wide valley, in which lie a number of low, sometimes jagged, kopjes, composed of a porphyritic variety of acid intrusive rock. This rock must be regarded as closely associated with that forming the main mass of the hill, for, though its dark matrix and conspicuous white felspars give it a different character in the hand-specimen, it is seen under the microscope to belong to the same class. Owing to its mineralogical and structural differences, the name "granite-porphyry" may be applied to it. Fairly abundant in it are dark patches of hornblende-schist, which was probably an interbedded associate of the slates already mentioned, and represents part of the older rocks into which the intrusion of acid rock occurred.

At the western end of Shamva Hill, where the ridge slopes away, the porphyritic variety outcrops close to the micro-granite, which at several points there (as, for instance, just south of the mine compound on both sides of the road to the pumping station) is conspicuously spotted with the dark compact patches which look like pebbles. Northwestward from Shamva, as far as Bindura, the conspicuous ridges in the landscape are probably all composed of similar intrusive rocks. At the latter place the ridges in the vicinity of the Kimberley Reefs mine are of micro-granite; and the others, as seen from the train, have all the same appearance. The district is characterized, therefore, by extensive acid intrusions, more particularly micro-granite and porphyries, into the old schists and slates. Similar intrusions are found elsewhere in Rhodesia, and they seem always to be an earlier phase of the same igneous activity which produced the grey granite, a rock with which they are generally closely associated. The greater part of Shamva Hill, including the top of the ridge and the whole northern slope, consists of the upper and outer portions of one of these intrusions; while the more coarse-grained granite-porphyry in the valley to the south is a more deep-seated portion of the same intrusion. The rocks into which these granitic masses were intruded are represented by the slates north of Shamva, and by the enclosures of hornblende-schist in the granite-porphyry. The basic dikes and sills are later intrusions into the granite rocks.

The whole series of rocks has been subjected to considerable crushing and to long-continued infiltration, resulting in extensive secondary silicification and carbonatization along the joints and cracks, and also in the body of the rock. The amount of secondary carbonates in the rock of Shamva mine is a marked feature, and it was difficult to understand where all the carbonates could have been derived so long as one was under the belief that the rock was a quartzite. When the true nature of the rock is recognized, and its minerals are studied under the microscope, the primary source of the carbonates is seen to be the still abundant felspar and the formerly abundant biotite. The rock's own decomposition products provide the material for both the secondary silica and the secondary carbonates.

THE GOLD DEPOSITS AT SHAMVA.—On the northern slope of Shamva Hill, between the top of the ridge and the open working of the mine, a line of prospecting pits marks the position of some quartz veins, or stringers, which yielded gold, though not in sufficient amount to encourage extended operations. It was, however, I understand, through the attention directed to these unimportant veins, that the discovery of the auriferous nature of a considerable section of the rock of the hill itself was made. This main orebody, now being worked by the Shamva company, lies some distance below the top of the hill, extending from the surface, with an average breadth of some 150 ft., down to the 2nd level, between which and the 3rd level it becomes considerably narrower, the narrowing being still more conspicuous from the 3rd to the 5th level. In length there has also been a shortening from the 2nd to the 3rd level, especially toward the eastern end, and considerably more again between the 3rd and 5th levels. From the present developments no values have yet been obtained below the 5th level.

The general shape and trend of the orebody, as revealed by development and stoping, is shown in Fig. 1, which is a transverse section from north to south; and in Fig. 2, which is a longitudinal one from west to east. As is shown in the transverse section, Fig. 1, the course of the orebody is more or less vertical down to the 2nd level, but its walls have a varying trend, and do not conform with any one set of the main joint planes of the rock. Below the 2nd level the values diverge from the vertical and the gold-bearing portion of the rock lies across the main jointing with a northerly dip. Between the 4th and 5th levels the gold-bearing zone is again vertical. The gold-bearing rock is simply a portion of the micro-granite, has been exposed and sampled on the different levels through a greater thickness than has yet been done on the foot.

When the gold-bearing portion of the micro-granite is examined, it is found to show little difference from the barren parts, and it is impossible to lay down any criterion by which valuable and valueless rock can be distinguished *in situ*. In many places the auriferous rock has numerous small veinlets of calcite or other carbonates, and the mass is divided up by more abundant jointing than the country

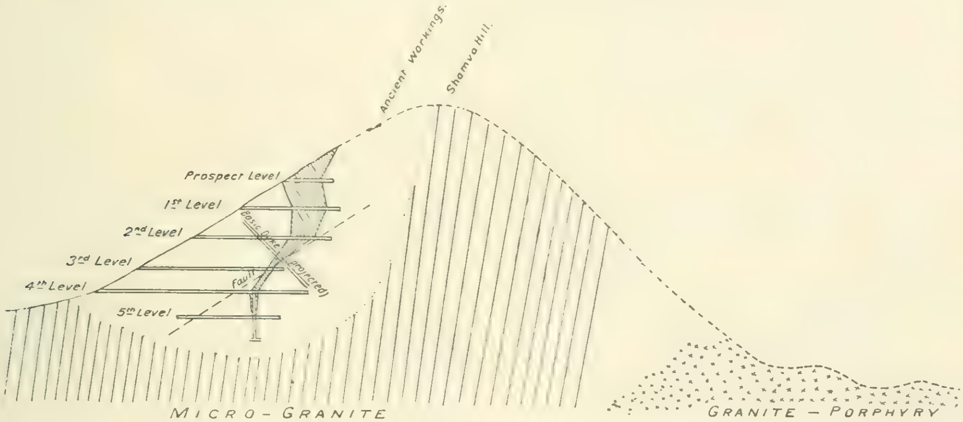


FIG. 1. CROSS-SECTION OF SHAMVA HILL.

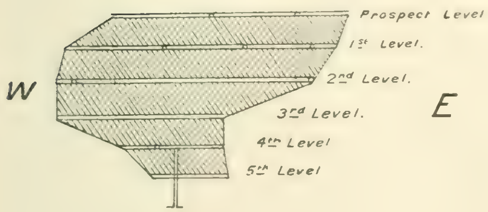


FIG. 2. LONGITUDINAL SECTION OF OREBODY.

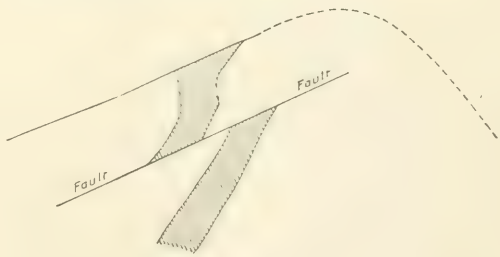


FIG. 3. DIAGRAM SHOWING POSSIBLE FAULTING.

with no regular boundaries, and with a varying width and trend as it has been followed downward. It must also be remembered that the portion selected for mining does not comprise the entire gold-bearing mass, but only that portion of it which carries gold above a particular value. The boundaries of the gold-bearing zone have been found more abrupt on the hanging than on the foot-wall. In the latter position gold has been found in places behind comparatively, or actually, barren zones; and there is also, as a rule, a more gradual dying-out of values where the foot-wall has been explored than is the case in the hanging wall. Owing to the development of the mine having been carried on by adits from the face of the hill, through the hanging wall, the latter rock shows. It would seem to hold good throughout that where the main joints are few and relatively widely separated, gold values are absent. On the other hand, very hard compact rock, difficult both to drill and to break, is not characterized by low values. It is correct, however, to say that, within the limits of the orebody, one may find all the variations in the rock which are found in the country; while, in some parts of the latter, barren rock is found with as abundant carbonate as is contained in the gold-bearing portion. Visible gold has occasionally been found in oxidized veins, or cracks, lined with a clayey hematite. The gold, however, must in general be very finely distributed; none occurs in the microscope slides I had made.

The presence of so much calcite shows that all through the rock percolation had occurred very extensively. In places, openings are also seen underground exactly similar to the "pipes" which are found in limestones, and these openings are often lined by clayey weathered material, just as is seen in a limestone pipe. There has been much transfer of material by percolation, and the carbonate veinlets are striking evidence of this, the carbonate material having been derived from the primary constituents of the micro-granite, especially from the felspar and the mica. The percolation which has taken place must also be assumed to have affected the distribution of the gold, producing some of the variations in value which occur from place to place.

It is difficult, however, in a rock of this type to distinguish between the variations in gold-content due to primary conditions and those due to secondary. It is also difficult to explain the limitation of the gold to that portion of the micro-granite now known to be gold-bearing. The eastern limit of values from above downward has a certain coincidence with the trend of one of the gullies which originally carried the storm-water off the surface of the hill, and there is a corresponding, though less marked coincidence, of the western limit of the deposit with another small ravine. Whether any process of leaching has been effected by the surface waters, entering the rock in the vicinity of the ravines, is a question for whose solution there are at present no data. If such leaching did occur, the place to which the gold has been removed has not been discovered.

The dikes, as far down as they have yet been met, are much more weathered than the acid rock. As already mentioned, they play no important part in the structure of the hill, nor have they had any effect on the gold contents. The trend of a portion of one is shown projected on Fig. 1.

On the 3rd level, below the gold-bearing portion of the rock, a fault or fracture is very apparent. This passes obliquely downward (see Fig. 1) through the deposit, and is found in the hanging wall on the 4th level. If the known portion of the fault line, as shown on the section, is continued upward, it is found to coincide closely with the slope of the base of the orebody from the 3rd up to the 2nd level. The change of trend which the base of the orebody makes between the 2nd and the 3rd levels is striking, and the question naturally arises whether the fault has had any effect on the gold-bearing portion of the rock. The available evidence is rather that the fault has not been the cause of the diminution in size of the orebody, but that the smaller areas of gold-bearing rock opened on the 3rd, 4th, and 5th levels are the normal continuations of the larger body above. In other words, the "fault" is only a fracture, and not a fault, in the accepted sense of a break along which a displacement has taken place.

The development below the 2nd level has given the position and shape of the orebody on the three lower levels, and there is no evidence, other than the existence of the very marked fracture, to suggest that the lower portion of the gold-bearing rock is not the normal continuation of the upper. On the other hand, in a rock of the nature of the micro-granite, where there is little distinction between adjacent masses, it might be that some displacement has occurred, and that the narrower body of gold-bearing rock below the fault belongs to the hanging or foot-wall country in relation to the upper part of the deposit. If there has been any displacement along the fracture it is likely to be that of a normal fault, the upper part of the orebody having been moved downward and forward away from the main mass, which would be farther in the hill. Fig. 3 shows how the position of the upper portion of the orebody may be explained on the theory of a displacement. The prospecting operations which I shall suggest can be directed toward settling this as well as other questions. I think, however, that it is more likely that we have to face the fact that the present extent of gold-bearing rock down to the 5th level is one particular shoot, and that the limits as shown by the present workings give practically its entire mass.

There is, however, quite reasonable hope that other orebodies exist, either in the hitherto unexplored mass of the micro-granite or on some part of its periphery. The existence of the Cymric deposit is an encouraging feature, for, as I have said, it too is in the same intrusive mass.

PROSPECTING OPERATIONS.—To prospect the micro-granite I should advise a cross-cut south being in the first place put into the hill. This will not only prospect the hill generally, but it should also settle the question whether the upper portion of the orebody has been displaced along the line of fracture from a main mass inside of the hill, as is indicated on the diagram Fig. 3. The cross-cut should be carried on until either the coarse-grained granite-porphyry is reached, or, failing this, until the hill is penetrated. If a dike or sill is reached it should be driven through, unless it occupies the remainder of that portion of the hill. Prospecting should also be carried out on the surface along the northern edge of the micro-granite next the slate. There may be contact veins of value on the outer edge of the micro-granite north of the Cymric. It is also desirable to prospect the whole of the micro-granite between the slate on the north and the slope of Shamva Hill, that is, practically the whole of the hanging-wall country of the present-known deposit. Prospecting at depth should also be undertaken, but whether simultaneously with the other is a matter for the consulting engineer to decide. A foot-wall cross-cut from the 4th level would be very desirable, but it could wait until the 2nd level has been thoroughly explored. Work on the 5th and 6th levels could wait until the results of the other are known.

The conclusion to which I have arrived is that practically the whole of the micro-granite should be prospected, there being every reasonable ground for the hope that other gold-bearing zones, similar to the two at present known, exist in it.

FAULTING IN ST. AGNES DISTRICT, CORNWALL

By JOHN B. FERN.

The author shows that the last set of faults are horizontal displacements, not falls of the hanging wall as previously supposed.

IT is well known that the district of St. Agnes is remarkable for the existence of extensive examples of complex faultings, and numerous papers have been written thereon by eminent observers. I have had opportunity during the past ten years to study closely the development of a particularly complicated area at Wheal Kitty and Penhalls United Mines, and, as a result, have come to the conclusion that some of the theories hitherto held with reference to faulting are not correct.

A brief description of the various lodes is necessary, in order to demonstrate my point. The country rock is a laminated clay-slate, locally known as killas. The traversing lodes in their order of formation are: (1) north-underlying tin lodes (the main lodes) with a strike east and west; (2) south-underlying tin and copper lodes with a strike east and west; (3) slides (sometimes termed gozzans) underlying south and coursing east and west; and (4) cross-courses dipping usually to the east, but occasionally to the west and bearing north and south.

The north-underlying lodes are directly faulted by the south-underlying lodes with the descent of the hanging wall of the latter; both the north and south-underlying lodes are normally faulted by the slides, again by the descent of the hanging wall of the faulting vein; and the whole series, the north and south-underlying lodes and the slides, are faulted by the cross-courses. It is with the action of these cross-courses that I propose to deal in detail.

The theory mainly advanced by previous writers has been that of the descent of the hanging wall of the cross-course, it being taken that, as is usual with dip faults, the heave is only apparent. This theory is satisfactory enough when the north-underlying main lodes only are considered. When, however, the effect of the fault on veins of opposite underlie is observed, it becomes clear that no descent of the hanging wall of the cross-course can have taken place.

The sections on the next page illustrate my argument. Figure 1 shows actual cross-sections by survey of the ground immediately east and west of the principal cross-course, dipping east, in Wheal Kitty. In this figure, the section west of the cross-course is indicated by continuous lines, that east of the cross-course by dotted lines, while the cross-course is assumed to be in the plane of the paper. Figure 2 shows the same section west of the cross-course in continuous lines, with an assumed section east of the cross-course in dotted lines, based on what should have happened if a descent of the hanging wall of the cross-course had occurred. A study of Figure 1 indicates that the direction of movement by the fault is wholly lateral, both the slides *a* and *b*, and the sections of lode *c*, *d* and *e*, being thrown south an equal distance. Obviously, if a down-throw had occurred as suggested on the assumed dotted section shown in Figure 2, the slides *a* and *b* would have been heaved to the north and the sections of lode *c*, *d* and *e*, would have been heaved to the south.

In a paper on "The Lodes of the St. Agnes

District," read by Mr. J. S. Whitworth before the Cornish Institute of Engineers in May 1914, the author, referring to faulting by cross-courses, mentions as his most instructive example that "The main cross-course in Wheal Kitty heaves the main slide, which dips south, 14 fathoms to the north, and the Wheal Kitty lode, dipping north, 32 fathoms to the south when going east."

This is quite correct as far as the lode is concerned, but it has subsequently been proved

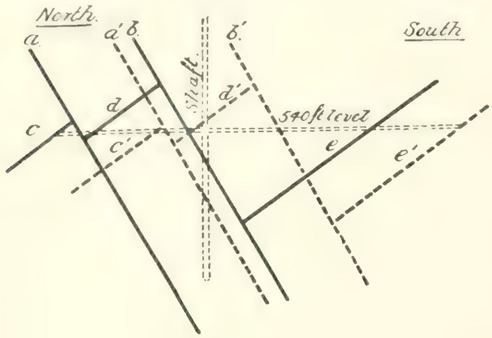


Fig I

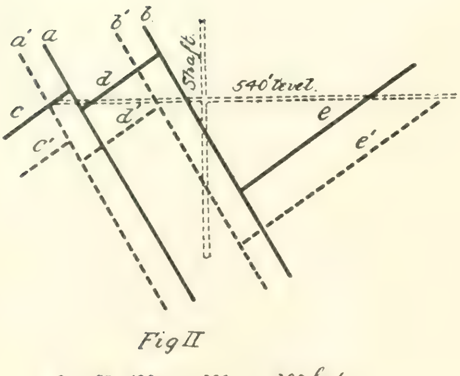


Fig II

that the slide which had been apparently thrown north 14 fathoms was not the main slide, marked *b* in Figures 1 and 2, but the small slide *a*, heaved 32 fathoms to the south, and which happened to be in the same position as the main slide would have been had it moved, as had been assumed, 14 fathoms to the north. The main slide has since proved to have been heaved similarly in distance and direction to both the lode and the small slide, that is, 32 fathoms to the south. The cross-sections examined by Mr. Whitworth with reference to the effect of this cross-course were made by myself, and both the late Mr. J. H. Collins and myself were of opinion at that time that the displacement was caused by descent of the hanging wall of the cross-course, and that consequently the small slide intersected (the adjective refers to the heave by the slide and not its appearance) was the main one, but, as I have already said, subsequent development proved otherwise.

That the importance of this point is considerable is shown in Figure 2, where it will be seen that had a down-throw taken place as supposed, the cross-cut at the 540 ft. level would never have met the sections of lode *c* and *d*. Conversely, if under a scheme of development based on the down-throw theory, cross-cuts were to be driven to intersect the junction (Figure 2) of the lode *e* with the slide *b* or the lode *d* with the slide *a*, their object would never have been effected, as these junctions, as shown in the actual sections of Figure 1, are 80 ft. above the position at which they would have been met had there been a down-throw.

Space does not permit me to give others of the many examples of this faulting, but as far as this particular district is concerned, the direction of movement in faulting by a cross-course has been proved by definite facts revealed by mine developments to be lateral, cross-courses dipping east moving all veins crossing their strike to the right-hand; those dipping west to the left-hand, no matter from which side, east or west, the cross-course is approached.

In conclusion it is only fair to point out that no good opportunity was afforded those who advanced the down-throw theory to observe *in situ* the effect of cross-courses on veins of opposite underlie, for the simple reason that developments necessary for exposing the direction of movement of south-underlying veins had not been carried out.

It is well known to experienced miners and geologists that true heaves are commoner in paleozoic rocks than is suggested by reading the text-books. The difficulty of differentiating between movements down the dip and along the strike in the case of dip faults has usually hindered correct diagnosis. The actual proved example of a purely horizontal movement given above is therefore worth while putting on record.

Economy in fuel is receiving widespread attention. Dr. W. A. Bone's committee of the British Association recently published a preliminary report, and will issue others from time to time. The subject has also received the attention of the Royal Society of Arts, where Dr. J. S. S. Brame is delivering a series of lectures on Coal and its Economic utilization.

EXCERPTS FROM MR. JUSTICE EVE'S JUDGMENT IN THE GLOBE & PHŒNIX CASE.

The judgment of Mr. Justice Eve in the case of the Amalgamated Properties of Rhodesia versus the Globe & Phœnix would cover twenty of our pages. We give herewith some of the salient features of the judgment, which on all points was in favour of the defendants.

THIS action is in the nature of an action for specific performance; the plaintiffs, who are the successors in title to the vendors, allege that the defendants, the purchasers, are liable to pay them a large sum of money by way of further purchase moneys for certain premises sold and assured to the defendants in 1912. The defendants deny that any further moneys are due and payable to the plaintiffs, and that is the issue between the parties. The contract is dated June 15, 1912, and the predecessors of the plantiffs thereby agreed to sell and the defendants to purchase a block of ten gold mining claims known as John Bull for the sum of £1000 in cash, and it was further provided that in addition to that sum the vendors should retain an undivided one half share or interest in any minerals which might be found in the said block of claims and in any proceeds obtained from such minerals. The claim of the plaintiffs relates to the one half share or interest in minerals found in the block and the proceeds obtained therefrom. Does their right under the contract extend, as they allege it does, to half the proceeds of all the minerals extracted subsequent to the agreement from land lying vertically under the surface area within which the block of ten claims is located, or is it, as the defendants contend, limited to half the proceeds of such minerals, if any, as may be extracted from the block under and pursuant to the mining rights exercisable by the holder of the block? In answering that question it is material to remember that at the date of the agreement the purchasers were holders of and were working claims contiguous to the John Bull block and that vendors and purchasers alike must be taken to have been cognizant of the extra-lateral right of pursuit possessed by the holder of a block of reef claims.

The property sold may be described as follows: To the John Bull block of claims the plaintiffs had an indefeasible title at the date of the contract; and, as holders of the block, they possessed:

(1) The exclusive right of mining all such portions of the ore-bearing reef upon which the claims had been originally located or pegged off—known as the Discovery reef—as might be comprised within planes passing through the boundaries of the block or surface projected indefinitely vertically downward, or, in other words, within the vertical block;

(2) The extra-lateral right of pursuit within certain limits of such portions of the Discovery reef as might lie on, or in the direction of, its dip, or as might descend outside the limits of the block;

(3) The right to register any reef other than the Discovery reef passing in its course within the boundaries of the block and known as a Secondary reef;

(4) and (5) Rights to work and laterally to pursue a Secondary reef corresponding to the rights exercisable in relation to the Discovery reef;

(6) The right, subject to any existing public rights and to any conflicting rights of the landowners in the case of a mining location situate on private land, to use the surface area enclosed within the boundaries of the block for all necessary purposes of the location.

* * *

The only valid right which the plaintiffs can assert to further purchase moneys is a right to half the proceeds of any minerals which may have been abstracted by the defendants from the John Bull block in the exercise of the express rights possessed by the plaintiffs' predecessors as claim-holders at the date of the contract. This interpretation of the mutual rights of the parties involves the inquiry whether the right to work the minerals abstracted by the defendants from ground lying within the vertical block of the John Bull claims was acquired by the defendants under the contract, or whether, as they allege, they then already had a paramount title to the minerals by virtue of their rights as holders of the adjoining claims, to follow or pursue their Discovery reef extra-laterally within the vertical limits of the John Bull block. By their defence they allege that the minerals so abstracted were in fact part of their Discovery reef. Upon this allegation issue was joined and to the solution of this question of fact the whole of the evidence occupying over 80 days in the hearing and necessitating over 50,000 questions and answers has been directed. The defendants' case is that from the surface to a depth of 2200 ft. vertically, and of nearly 3000 ft. on the incline, they have been continuously following and working the same reef; the plaintiffs on the other hand assert that the Discovery reef was never worked to a greater depth than from 500 to 600 ft. from the surface and that below that depth the defendants have been working from separate reefs each distinct from the other and all distinct from the Discovery reef. It is not necessary for their success on the issue of fact between the parties that the plaintiffs should succeed in proving the existence of this multiplicity of reefs in the defendants' workings. It is enough for them if they can prove one missing link in the defendants' alleged unbroken chain.

The evidence falls under three heads, which I shall designate as the "prehistoric," the "contemporaneous" and the "retrospective." The prehistoric evidence is wholly oral. For more than one reason I do not think I can avail myself of the prehistoric evidence as a help toward the solution of the problems I have to face. In the first place these eminent scientists differ not only in the conclusions to which their researches and experience lead them, but they are by no means agreed on any common basis of facts on which to found their opinions, or from which to draw their deductions. In the next place geology is not a science upon which anybody would wish to dogmatize. The evidence has demonstrated that in many matters relating to the particular area in which this mine is situate, and to this very mine itself, opinions have vacillated and changed within very recent times, and it by no means follows that the views expressed with more or less confidence in the witness-box in this case will be as firmly maintained in the course of a few years' time. Finally the question is one of practical commercial importance affecting the interests of men who are concerned only to know how they may turn their property to profitable use and who are profoundly indifferent to the exact geological era, epoch, period or age in which their particular lode came into existence so long only as they can satisfy a Mining Commissioner that they are working throughout on one and the same lode.

In the retrospective evidence the plaintiffs focus the several points in the mine whereat they allege the defendants passed from working one reef and started working a new and independent reef, and the portions of the contemporaneous evidence with which I propose to deal are in the main the portions relating to these points. The particular points indicated by the plaintiffs were:

(1) A point somewhere about the horizon of the 3rd Level, whereat they allege that the defendants ceased to work their main Discovery reef, started working a hanging-wall spur off the Discovery reef which at or about the horizon of the 4th Level began to die out and at a slightly lower depth finally died out against the foot-wall of the Parallel reef;

(2) A point between the 8th and 9th Levels where they allege that a new and hitherto undiscovered reef—the East reef as it has been called—apexed against the hanging wall of the Parallel reef;

(3) A point on the 12th Level where they allege are to be found the highest workings—that is to say, the workings nearest to the surface—of a third reef distinguished as the West reef; and

(4) A point at the extreme north end of the 12th Level, whereat they allege the North reef was first discovered and worked.

In turning to the contemporaneous records, let me state certain facts which I hold to have been incontrovertibly proved.

(1) That from surface to depth this mine has been worked throughout within the vertical limits of the defendants' locations and to some extent under the John Bull block from level to level and by extensive stoping between the levels and by winzes connecting the levels as one continuous sheet of ore with a more or less constant dip and with a consistently northerly trend of the ore-shoot.

(2) That the indications in the mine of successive convulsions, such as faults, dislocations, brecciation, shearing and the like, fall far short of what might reasonably have been expected if there be in fact five separate reefs in the mine, that is to say, five successive fissures opened by separate earth movements, and each filled with a gold-bearing lode or vein before the next fissure was opened.

(3) That no responsible agent of the defendant company ever realized the existence

of any reef other than the Discovery reef ; and

(4) That neither in mineral contents, nor in strike, nor in relative position to dykes or to one another is there anything inconsistent with the lodes being part of one reef deposited in a fissure which at places branched and threw off spurs or leaders or split round intrusions of country rock.

It is not possible to collate within reasonable limits the evidence upon which the foregoing findings are based, but I may say that as regards the first and second the general condition and aspect of the mine is not seriously in dispute, though the plaintiffs do rely on certain variations in the mineralization and in the strike or trend of the ore-shoot as negativing the continuity of the reef, and they point to the undoubted presence of slickensides in various parts of the mine as conclusive proof of differential movements of the walls of an opened fissure. This is conceded, but the point is then made that these very movements are in themselves sufficient to account for all the other evidences of convulsion and that no evidence is then left to support the theory of successive fissure-opening movements.

The third finding is not only in accord with the testimony of these officials of the company who have given evidence, but its correctness is surely placed beyond all reasonable doubt when it is realized that the same rights as appertained to the Discovery reef could have been acquired for any new reef by the simple procedure of registering it as a Secondary reef. It is inconceivable that this precaution would have been neglected had the competent agents of the defendant company even suspected that their workings were passing into a new lode.

The principal grounds upon which the fourth finding would not commend itself to the plaintiffs is that their witnesses have a profound disbelief in the existence of branching fissures at all, whether they be fault fissures or contraction fissures. This attitude of incredulity is accounted for largely by an absence of any personal experience of branching fissures in this locality, and a firm conviction that they are not to be found in the Phœnix mine, but I do not think this negative evidence ought to prevail over the collective weight of other indicia that the fissure or fissures here do in fact split, as indeed is shown on the plaintiffs' own case, and that there do exist in the mine many spurs and leaders which some persons might legitimately term branches. Moreover, it is to be noted that there are express sections in the Ordinances (Section 63 of the Ordinance of 1895 and Section 52 of that of 1903) dealing with reefs apparently distinct, but in reality merely branches of the same reef coalescing in depth (I am quoting the exact words of the sections) which would certainly go to show that the occurrence of such conditions was not regarded as improbable.

I turn now to the evidence of the defendants directed to the four several points at which the plantiffs allege a breach in the continuity of the Discovery reef workings.

* * *

[We quote the chief of the four points.]

I descend now to the stope between the 8th and 9th Levels. Does a new reef open against the Parallel there or does the Parallel in its descent split acroes the top of an intrusion of country rock? In my opinion the case which the plaintiffs have raised in reference to this locality is largely founded on an entire misreading of the contemporaneous reports, a misreading of which Mr. Upjohn's criticism has effectually disposed. The point is this: It is admitted that on the 9th Level there are two orebodies found instead of the one orebody on the 8th Level; it is further admitted, or if not admitted it is proved beyond controversy, that no one engaged at the mine ever connected this occurrence with any such theory as that advanced by the plantiffs in this action. Although in a few instances, particularly in the early reports after the split had been discovered, language is used which might indicate some doubt in the mind of the writer whether one or other of the two orebodies on the 9th Level might not turn out to be a new reef, a view which they consistently expressed, and which was throughout acted upon, was that the descending Parallel reef had split across an intrusion and was to be found for a comparatively short length in the 9th and the next three succeeding levels in two makes of quartz or veins, one on the west and the other on the east of the intrusion. The condition of things on the 9th Level was discovered in the summer of 1905, and eighteen months later, in December 1906, there occurs for the first time in the reports the expression "East portion." It is attached by way of description to that part of the easternmost of the two veins on the 10th Level which lies to the east of the intrusion, and the two veins so far as they lie longitudinally east and west of the intrusion, but no further—for at each end of the intrusion they join up again—are at times—but very occasionally only on that level distinguished as "East or front portion" and "West portion," but throughout—as on the

9th and equally on the 11th Level—the writers of the reports are treating the position as brought about by a split of the reefs starting from the 9th Level and proved to the 11th, and are in no sense contemplating a condition of matters involving the existence of separate reefs, that is to say, deposited or injected into separate fissures opened in different ages and by separate earth movements. The term "East reef" is not used in the reports until the 13th Level is reached, and then it is used not with reference to anything corresponding with the locality we are now considering, but with reference to a spot much farther to the south.

The mistake which the plaintiffs' advisers made in the beginning is illustrated by the colouring they have adopted in the exhibit C.B.K. 39. That exhibit so far as it is material on this point purports to show by the purple colouring the reef to which in their reports the defendants attached the name "East reef," and on it there appears in purple a length of reef on the 9th Level to which the word "East" let alone the name "East reef" never was applied. On the 10th and 11th Levels further lengths of purple are shown, although on these levels the only names used were "East portion" or "Front portion" and these only when the portion lying along the intrusion was referred to, and on the 12th a still longer length is coloured purple though the word "East" is never employed in reference to that level.

What is the result of this misrepresentation of the facts? It is this: that the defendants' experts set out to make their examination of the mine and made their report thereon and apparently came here prepared to give their evidence on a wrong assumption, that is to say, on the assumption that the defendants had from 1905 onward attached to this alleged new reef a distinctive name, the name of "East reef," and had therefore as from its first appearance on the 9th Level treated it as a new and distinct reef from the Parallel, whereas it now turns out that they had done nothing of the sort, that they had consistently treated and spoken of it as a split portion of the Parallel so far as the split extended, and north and south of the split as the combined reef, facts which of course necessitate a complete alteration of the colouring on C.B.K. 39. Experts who start to solve a difficult problem upon a complete, though quite innocent, misapprehension of very material facts must not be surprised if the Court does not attach very much weight to their conclusions. The misconstruction of the reports probably led the plaintiffs' experts to concentrate their attention on the stope between the 8th and 9th Levels to a much greater degree than they would have done had they visited the mine having before their mental vision a condition of things which would be brought about by substituting on C.B.K. 39 green colour for purple on Levels 9, 10, 11 and 12. Starting on their investigation as they did with a strong impression that the records evidenced the discovery of a new and independent reef on the 9th Level, they would have been more than mortal had they not devoted a great deal of their ingenuity and industry to the detection of phenomena calculated to convert that impression into conviction, and I cannot help feeling that in many respects this is what has occurred. If I might venture to criticize their evidence in a sentence, I think I should put it in this way, that having discovered something consistent with their preconceived impression, they have been too much inclined to adopt it as confirmatory of that impression without realizing that it might be equally consistent with another state of things altogether, and further that they have unconsciously magnified the importance of quite trivial details.

But after all, although subsequent discoveries may qualify and in some cases altogether upset antecedent conclusions, it is well, before allowing that they are to have that effect in any particular circumstances, to ascertain first exactly what were the data from which such conclusions were drawn and then to inquire how far subsequent discoveries are consistent or inconsistent with the conclusions. Now in this case two unimpeachable witnesses were called by the defendants to describe, as they did in a perfectly intelligible manner, what they found in the stope between the 8th and 9th Levels. The two witnesses gave evidence of a state of things which if it existed as they clearly intended to convey it did exist, established beyond all doubt the presence between these levels of one reef and one reef only with a split round a horse. A dominant feature in their description was the presence of one continuous wall on each side—hanging-wall side and foot-wall side—of the reef, and the obvious conclusion to which their evidence was directed was the proof that these walls were the containing walls of the one fissure in which the one reef had been deposited and that the intrusion or horse had been a mass of country rock which had fallen into or otherwise been included within the bounding walls of that fissure. The plaintiffs do not deny the existence of these two walls, but their case is that within the space between these two walls —which they would identify respectively as the hanging-wall of the Parallel and the foot-wall of the East reef—there were originally, that is to say, before the stoping took place, the foot-wall of the Parallel and the hanging-wall of the East. If the plaintiffs had given any evidence to support this contention it may well be that an examination of the idicia they rely on in the lower levels would have led me to the conclusion that events subsequent to the stoping between the 8th and 9th Levels were more consistent with the state of things they were asserting as having existed in that stope than with the defendants' assertions, and in such case the defendants' conclusion in favour of one reef might have been displaced by a finding in the plaintiffs' favour that there were two reefs in the stope.

But the plaintiffs not only have given no evidence as to what was in the stope; and of that one cannot of course complain, because the stope was all cleared and the reef removed from the critical points years before the plaintiffs ever went there—but they have deliberately abstained from asking either of the witnesses the critical question: "Did you not find or observe these inner walls ('false walls' as miners call them) in that stope, and were they not in fact stoped away with everything else that lay between the present containing walls?" As it is, the plaintiffs invite me to conclude from a number of indicia elsewhere than at the critical spot that the evidence given by the defendants' witnesses of what they found and observed at the critical spot is inaccurate and unreliable, although they have not had the courage to challenge the defendants' witnesses on this vital point when they were in the box and have allowed them to leave the country in the belief that what they said had been accepted as true. I accept as accurate the evidence of the practical men who worked ten years ago in the stope. I draw the same conclusions as did the other engineers of the defendants, from what that evidence discloses, and I see nothing inconsistent with these conclusions in any of the plaintiffs' theories or criticisms. In my opinion the "East reef" is a myth.

[The judge then proceeded to review other parts of the evidence.]

* * *

I have now dealt with the whole mine, and it follows from what I have said that in my opinion the plaintiffs have entirely failed to discharge the burden which lay upon them of proving that the defendants have abstracted minerals from under the John Bull surface for which they are accountable to the plaintiffs under the agreement. The defendants have proved to my satisfaction that from surface to depth, and from south to north they have worked but one reef—their original Discovery reef. And this finding really disposes of the action for what after all are the issues. The action is dismissed.

PERSONAL

EDGAR BONDS has returned to England from the Taquah mine, West Africa.

STANLEY C. BULLOCK has been promoted Captain in the Royal Engineers.

MAJOR LESLIE J. COULTER, a member of the Mount Lyell staff, has been awarded the D.S.O.

CHARLES FENNER, principal of the Ballarat School of Mines, has been appointed superintendent of technical education for South Australia.

Dr. JAMES VINCENT ELSDEN has been appointed treasurer of the Geological Society in succession to the late Bedford McNeill.

W. R. FELDTMANN has returned to London on the conclusion of his visit to the Ashanti gold mines.

Dr. A. M. FINLAYSON, who has a commission in the South Lancashires, was wounded in an action on the Somme front, but is now convalescent.

H. W. GEPP has concluded his long visit to the United States and is on his way back to Broken Hill.

N. E. GIBLIN has been appointed manager of the Edna May Central mine, Westonia, West Australia.

A. GOLDWATER is expected from Nigeria.

HARRY D. GRIFFITHS has left for Burma

J. S. HENRY has arrived at the Mendietta mine, Potosi, Bolivia, from Australia.

A. W. HOOKE, manager for the Bisichi and Forum River companies, left last month for Nigeria.

BERTRAM HUNT has gone to Venezuela for the Goldfields of Venezuela Limited.

CHARLES HUNTER has opened an office at 821 Salisbury House, London, E.C.

ARTHUR JARMAN has resigned as assistant superintendent of the Waihi Grand Junction mine.

J. IRVINE JAMESON, manager of the Leeuwpoort tin mines, is expected in London.

NEWTON BOOTH KNOX has returned to Spain on the conclusion of his visit to America.

ROLF MARSTRANDER has left Christiania, Norway, for the United States, to make investigations in the northwest in connection with petroleum occurrences.

JOHN HERMAN MERIVALE, formerly professor of mining in the Durham College of Science, and a past president of the North of England Institute of Mining and Mechanical Engineers, died on November 18, in his 68th year.

F. W. PAYNE has returned to New Zealand on the conclusion of visits to England, Malaya, and the United States.

ALEXANDER RICHARDSON has joined the staff of the Research Council.

WILTON SHELLSHEAR has resigned as mill superintendent for the Junction North mine, Broken Hill.

MAJOR U. P. SWINBURNE, who was wounded in France, will be returning shortly to his duties as Chief Inspector of Mines for the Union of South Africa.

DISCUSSION

Ore.

The Editor:

Sir—You will recall the lively discussion concerning the definition of "ore" appearing in your Magazine in 1912, 1913, and 1914. My effort to define the basic term of mining was not accepted by some of our friends, but I have reason to believe that the debate was useful in drawing attention to the looseness of current terminology. I write now to quote the definition of ore appearing in an official bulletin entitled "Suggestions to Authors," prepared by Mr. George McLane Wood, the editor of the United States Geological Survey. His definition of ore reads thus: "Ore is a mineral or rock from which one or more metals may be profitably extracted."

The definition suggested by me was: "Ore is metal-bearing rock that, at a given time and place, can be exploited to economic advantage."

It will be seen that the two definitions have much in common; the main point is that profitable extraction or economic exploitation are made an essential condition. I send my compliments to the many engineers that participated in the discussion during those ante-bellum days now so remote.

T. A. RICKARD.

San Francisco,
October 19.

Geology of the Shamva Mine.

The Editor:

Sir—Many of your readers will, no doubt, have perused with interest the geological report on the Shamva mine which has recently been issued to the shareholders. It gives for the first time an authentic account of the shape and size of the orebody, as well as a discussion of the future prospects of the mine. With the purely economic question I have no concern, except in so far as it is necessarily affected by the geological features of the deposit. I should, however, like to take this opportunity of pointing out that there is an alternative explanation of these last, differing from the one which is put forward by Dr. Corstorphine. It will be found on pp. 208-9 of this Magazine for September 1913. For convenience I reproduce my observations as follows:

"The conglomerates at Abercorn have long been known. It is only recently, however, that any portion of the series to which they belong has been found to carry gold. They are of great apparent thickness, the beds reaching from the Mazoe river to beyond the now famous Lone Star hill, a distance of fully three miles. The strike is approximately east and west, the beds stretching in the latter direction toward Lomagundi, but they are cut off from the rocks previously described not only by the great intrusion of picrite and serpentine making up the Umvukwe hills, but by a considerable stretch of granite. They are, however, different in aspect; indeed, the series is predominantly a thick sequence of grits with only occasional bands of pebbles. It would be difficult, without the aid of the latter, to get an idea of the true strike and dip of the beds, as there are practically no signs of bedding planes in the grits. Near the Mazoe river the larger pebbles, which are always well rounded, are often about four inches long. On the Lone Star hill, however, at the Shamva mine they seldom reach greater dimensions than about an inch in length. A slice of a specimen from the No. 2 adit at this locality shows well rounded chert-like pebbles in a matrix chiefly composed of quartz grains. These latter have evidently suffered from crushing and cracking since the original consolidation of the rock. There has been some infiltration both of secondary silica and pyrite, and also of a yellowish strongly refracting mineral, which is probably epidote. There are some grains of felspar present, and among these a few show microcline structure, though this is rather indefinite and may be not original but due to strain. The chert-like pebbles sometimes have a distinctly banded appearance, and are most probably derived from the banded ironstone series. These pebbles are often as much impregnated with pyrite as the matrix of the rock. It may be noted that the great feature of the Shamva orebody is its remarkable width. This implies that the gold is by no means confined to the pebble bands, which are often only a few inches across, in fact the occurrence of the gold does not appear to be connected with the presence or absence of pebbles, the intervening grit being often just as rich as the pebble bands themselves. Veinlets of quartz and sulphides always appear to be favourable signs of gold in the ore."

It is not clear why Dr. Corstorphine prefers a different reading of the facts. His view that the Shamva Hill is a large mass of "micro-granite" does not explain why there should be running through it at intervals well defined pebble-beds with a regular east and west strike and dip to the south. The pebbles are well rounded, and the suggestion that they may represent the fine-grained groundmass of the rock in no way meets the obvious objections provided by their size, shape, or distribution, or the further facts that they are often banded and never show any porphyritic crystals or other indications of the origin that Dr. Corstorphine attributes to them. If their uniform appearance is any difficulty in the way of considering them as pebbles in a sedimentary rock, it applies in equal measure to the banket of the Rand. Their boundaries are quite as sharp as in the latter rock, the fact being that in neither of these ancient deposits is it easy to say precisely where primary and secondary quartz begins owing to the crushing which they have undergone since the Archean period. The series of rocks in which they occur is as a whole strictly comparable with the Moine gneisses of the Scottish Highlands, which are well recognized to be of sedimentary origin. I do not wish for a moment to be understood as asserting that igneous rocks are absent from the locality. On the contrary there are important intrusions of igneous material in and around the mine. In fact a fairly intimate acquaintance with the neighbourhood enables me to state with some confidence that neither the mine itself nor the surrounding district possesses that alluring simplicity of structure which might be supposed from Dr. Corstorphine's report.

F. P. MENNELL.

377 Salisbury House, London,
November 21.

[Dr. Corstorphine's report is printed in full in another part of this issue.—EDITOR.]

The Spassky Copper Mine, Ltd.

The Editor:

Sir—In the November issue of the Magazine a reference concerning this company appears under the personal column. I am instructed to point out that while it is correct that Mr. H. C. Woolmer will retire from the management of the Spassky and Atbasar mines at the end of this year, the statement that he will then be appointed managing director of the company is inaccurate. Mr. Woolmer's connection with the company terminates entirely at the end of this year.

FOR THE SPASSKY COPPER MINE, LIMITED,

JOHN A. CLARK,
London Manager & Secretary.

60 London Wall, London, E.C.,
November 22.

Cornish Tin and Tungsten Research.

The Editor:

Sir—In the November issue of the Magazine your Camborne correspondent suggests the possible supersession of the present joint committee for Cornish tin and tungsten research, "whose investigations" he states, "seem not to be making a start."

Your correspondent, though usually well informed, is quite wrong in this case, as the negotiations between the joint committee referred to were brought to a satisfactory conclusion on October 23 last, on which date the research direction committee definitely started the joint research work, and many branches are now in active prosecution. I may add that the actual work of tin and tungsten research was started by the Institution of Mining and Metallurgy over six months ago. A considerable amount of research work has already been done. One branch of the research is nearly completed and promises very satisfactory results.

It is amusing to point out that your correspondent's left-handed compliment to Cornishmen about the want of "intimate acquaintance with the character of the Cornishmen and the conditions ruling here" must also have been shown by those in London who proposed to start the Cornish Chamber of Mines, and this may also have been the cause of the block in their negotiations.

Truth to tell, it may be that those who were engaged in the negotiations with the Royal Cornwall Polytechnic Society may know quite as much about Cornishmen and Cornish conditions as your correspondent, who in the next column of the Magazine deplores the lack of co-operation among the Cornish mining interests, and goes on to speak of the petty jealousies which he says exist. The less we get of that sort of correspondence the better for "one and all."

W. H. TREWARTHA-JAMES.

London, December 6.

The Proposed Trade Bank.

The Editor:

Sir—The proposal for the establishment of a British Trade Bank will receive support among those interested in the production of minerals. At the beginning of the present year I wrote to Mr. Runciman, the President of the Board of Trade, suggesting the foundation of an institution of this character, especially with reference to mining and metallurgical interests. In order to keep the agitation alive, it may be suitable for me to repeat here some of the arguments I employed in my letter to Mr. Runciman.

Mining and metallurgical engineers frequently have to deal with the marketing of minerals from various parts of the British Empire and other countries, and consequently they come into direct contact with difficulties which should be removed. There is undoubtedly an urgent need for the establishment of a central financial and technical organization in order to assist, and possibly control, the importation of minerals used in the arts and now for munition purposes. The position of some of the smaller mines is often a difficult one on account of insufficient working capital and the necessity of obtaining cash payment for the mineral before it leaves the port, or even sometimes the mine. Many of the minerals and ores imported into this country are paid for on arrival against the usual assay and weight certificates, and many struggling mines are unable to finance consignments of mineral in transit. The result is that the metal and mineral merchants often have to advance from 50% to 90% of the value of the mineral against documents at the port of shipment; and the mine-owners thus receive a considerably lower price for their products than would be the case had they sufficient funds to enable them to wait until the ore is actually paid for at the place of consumption, as the merchant financing such concerns is compelled to protect himself, by frequently making an abnormal profit on the sale of the mineral, against likely fluctuations of the markets and freights.

If a national institution, or a bank, were established in co-operation with the leading Joint Stock and Colonial banks for facilitating and simplifying the financing of mineral consignments, I think the benefit derived from such an institution would be apparent very quickly. In order to illustrate my meaning I will mention two typical cases which have come to my notice recently. In the first case antimony ore was offered from a reliable source abroad, but the producers wanted 50% of the agreed price of the mineral against documents at the port of shipment; on the other hand the refiners of antimony here will only buy c.i.f. and not f.o.b. The result was that the matter had to be handed over to a firm of enterprising mineral merchants who agreed to advance 50% of the value of the mineral against documents, but offered such a low scale of payment that the business became practically impossible.

A second typical example was in connection with wolfram. When the war broke out I approached people in this industry and informed them that large contracts could be made at the rate of about £100 per ton for high-class wolfram ore, whereas the price was shortly afterward fixed by the Government at about 55s. per unit or about £200 per ton. I pointed out at the same time (October 1914) to the consumers that if they wished to make contracts ahead it would be necessary for them to advance against assay and usual documents in Burma, but they refused business on these lines, and would only buy c.i.f. Liverpool. I also endeavoured at the time to get a Colonial bank to make such advances, but without success. Had an institution such as a Trade Bank existed at the time, the matter would have been quite simple, and money would have been saved indirectly to the country, as the producers were only too anxious to make contracts ahead, seeing that they had lost the German and Austrian markets.

Such an organization would naturally have to appoint duly authorized agents and assayers, assisted by local mining boards and consuls at the ports and in the countries where the minerals are produced. It is owing to such methods that the Germans have been so successful in dealing with this particular branch of the industry. With the resources at the disposal of the British Empire and the practically unlimited supplies of minerals of zinc lead, copper, antimony, bismuth, wolfram, tin, etc., this matter deserves attention.

The establishment of such an enterprise would necessitate the action of a joint financial and technical committee, possibly assisted by independent metal and mineral merchants. The operations of the institution would not necessarily involve it in any material degree of speculation, for the committee would be thoroughly acquainted with market conditions, and it could make provision against such contingencies, including loss of cargo in transit.

O. J. Stannard.

London, November 23.

METAL MARKETS

COPPER.—Again we have to record a substantial rise in prices. Standard closed on November 30 at £151. 10s. for cash and £143 three months, whereas at the beginning of November the respective values were £124. 5s. and £119. 10s. Demand has in this country been steady, and consumers are forced to cover against orders wherever they can find sellers. The consumption in the United States is growing, especially for internal requirements, as the new naval programme on that side of the Atlantic is making heavy demands upon output. Indeed it is calculated that the current consumption is much in excess of current production. Whether the increased exports from Australia and Japan will supply the deficiency is a matter of conjecture. There is undoubtedly considerable mining activity in all copper-producing centres. The latest quotations for electrolytic copper in America are 34½c. for early delivery and 32½ to 33½c. for forward. At the beginning of the month the price was 28¼ to 29¼c. The English price has risen in the same period from £145–£141 to £170–£167. After such an advance, demand has somewhat quietened, but producers have sold well and are little disposed to make concessions. On December 9 the Government took over the control of the copper market.

TIN.—Prices held steady but firm until late in the month of November, when the market took a turn upward, and closed at £190. 7s. 6d. cash and £192. 7s. 6d. three months, representing a rise of nearly £9. English tinplate makers have only bought sparingly, and it is estimated that under 40% of the normal capacity of the mills is in operation. American consumption on the other hand has increased, and there is an active business being done in direct steamers from the Straits, especially from Java to New York. Purchases on behalf of the various governments has been a feature of the month; in fact in view of these it is a little surprising that the rise has not been more pronounced. A few consignments have been sunk in Mediterranean waters destined for Italy and France, but these have made little apparent impression on market prices. Shipments from the East have been heavy, but they are likely to fall off in the New Year. Publication of prices has been suspended.

LEAD.—No change has occurred in the official price, which is £30. 10s.–£29. 10s. The metal is in constant demand, but the transactions outside requirements for munitions are exceedingly limited. The question of supply is rendered more urgent by the irregularity of shipping facilities from Spain.

SPELTER.—The official price has risen steadily from £52. 15s.–£50. 15s. to £59. 10s.–£58. Interest has developed for forward delivery, and American consumers are buying freely. The market over there is reported as very strong. Brass makers on this side are also good buyers, but the galvanizing demand has almost died out. This year's production in the United States is estimated as 700,000 tons, and for 1917 the producing capacity is given as 800,000 tons. The American quotation is a good deal above London parity, and in spite of the large production stocks are not plentiful. On December 9, the Government asked the newspapers not to publish prices of spelter.

NICKEL.—£225 per ton.

QUICKSILVER.—£18. 15s. per flask of 75 lb.

No quotations for ANTIMONY, ALUMINIUM, PLATINUM, BISMUTH, CADMIUM, TUNGSTEN, or MOLYBDENUM.

SILVER.—The price continues to rise, and has been about 36d. per oz. during the last week or two,

PRICES OF CHEMICALS. December 8.

Owing to the war, buyers outside the controlled firms have a difficulty in securing supplies of many chemicals, and the prices they pay are often much higher than those quoted below.

		£	s.	d.
Acetic Acid, 40%	per cwt.	1	18	0
,, 60%	,,	2	16	0
,, Glacial	,,	6	0	0
Alum	per ton	14	0	0
Alumina, Sulphate of	,,	18	10	0
Ammonia, Anhydrous	per lb.		1	9
,, 0·880 solution	per ton	32	10	0
,, Chloride of, grey	per cwt.	1	14	0
,, ,, ,, pure	,,	3	10	0
,, Nitrate of	per ton	55	0	0
,, Phosphate of	,,	85	0	0
,, Sulphate of	,,	17	0	0
Arsenic, White	,,	38	0	0
Barium Chloride	,,	30	0	0
,, Carbonate	,,	7	0	0
,, Sulphate	,,	5	10	0
Bleaching Powder, 35% Cl.	,,	25	0	0
Borax	,,	33	0	0
Carbolic Acid, 60% Crude	per gal.		3	6
China Clay	per ton	1	10	0
Copper, Sulphate of	,,	65	0	0
Cyanide of Potassium, 98%	per lb.		1	0
,, ,, Sodium, 100%	,,			10
Hydrofluoric Acid	,,			6
Iodine	,,		13	9
Iron, Sulphate of	per ton	4	5	0
Lead, Acetate of, white	,,	85	0	0
,, Nitrate of	,,	65	0	0
,, Oxide of, Litharge	,,	42	0	0
,, White	,,	47	0	0
Magnesite, Calcined	,,	15	0	0
Magnesium Sulphate	,,	10	10	0
Oxalic Acid	per lb.		1	7
Phosphoric Acid	,,			10
Potassium Bichromate	,,		1	4
,, Carbonate	per ton	105	0	0
,, Chlorate	per lb.		2	4
,, Chloride, 80%	per ton	55	0	0
,, Hydrate (Caustic) 90%	,,	300	0	0
,, Nitrate	,,	60	0	0
,, Permanganate	per lb		10	0
,, Prussiate, Yellow (Ferricyanide)	,,		4	0
,, Sulphate, 90%	per ton	60	0	0
Sodium Metal	per lb		1	3
,, Acetate	per ton	70	0	0
,, Bicarbonate	,,	6	15	0
,, Carbonate (Soda Ash)	,,	7	0	0
,, ,, (Crystals)	,,	3	5	0
,, Hydrate, 76%	,,	22	0	0
,, Hyposulphite	,,	13	0	0
,, Nitrate, 95%	,,	18	10	0
,, Phosphate	,,	30	0	0
,, Silicate	,,	7	0	0
,, Sulphate (Salt-cake)	,,	2	2	6
,, ,, (Glauber's Salts)	,,	3	10	0
,, Sulphide	,,	22	0	0
Sulphur, Roll	,,	18	0	0
,, Flowers	,,	18	0	0
Sulphuric Acid, B.O.V.	,,	3	15	0
,, Fuming	,,		—	
Superphosphate of Lime, 18%	,,	5	10	0
Tin Crystals	per lb.		1	4
Zinc Chloride, solution 100°T.	per ton	31	0	0
Zinc Sulphate	,,	25	0	0

STATISTICS.

Production of Gold in the Transvaal.

	Rand	Elsewhere	Total	Value
	Oz.	Oz.	Oz.	£
Year 1912	8,753,563	370,731	9,124,299	38,757,560
Year 1913	8,430,998	363,826	8,794,824	37,358,040
Year 1914	8,033,567	344,570	8,378,139	35,588,075
Year 1915	8,772,919	320,752	9,073,671	38,627,461
January 1916	759,852	27,615	787,467	3,344,948
February	727,346	26,248	753,594	3,201,063
March	768,714	27,975	796,689	3,384,121
April	728,399	26,273	754,672	3,205,643
May	751,198	26,483	777,681	3,303,377
June	735,194	26,570	761,764	3,235,767
July	733,485	27,602	761,487	3,232,891
August	752,940	28,210	781,150	3,318,116
September	744,881	26,686	771,567	3,277,408
October	764,489	27,850	792,339	3,365,642
November	756,370	26,696	783,066	3,326,253

Natives Employed in the Transvaal Mines.

	Gold mines	Coal mines	Diamond mines	Total
July 31, 1915	190,026	9,371	—	199,397
August 31	196,866	9,943	—	206 809
September 30	204,833	9,743	—	214,576
October 31	210,017	9,513	—	219,530
November 30	210,068	9,432	—	219,500
December 31	209,438	9,309	132	218,879
January 31, 1916	209,835	9,228	802	219,865
February 29	209,426	9 468	970	219,864
March 31	203,575	9,588	917	214,080
April 30	199,936	9,827	938	210,701
May 31	194,765	9,811	1,459	206,035
June 30	192,809	9,859	2,105	204,773
July 31	192,130	9,932	3,339	205,401
August 31	194,112	10,086	5,146	209,344
September 30	197,734	10,239	6,527	214,500
October 31	199,330	10,907	6,358	216,595
November 30	196,132	11,118	5,928	213,178

Cost and Profit on the Rand.

Compiled from official statistics published by the Transvaal Chamber of Mines. The profit available for dividends during 1915 was 63% of the working profit.

	Tons milled	Yield per ton	Work'g cost per ton	Work'g profit per ton	Total working profit
		s. d.	s. d.	s. d.	£
Year 1912	25,486,361	29 2	19 3	9 11	12,678,095
Year 1913	25,628,432	27 9	17 11	9 6	12,189,105
Year 1914	25,701,954	26 6	17 1	9 0	11,553,697
Year 1915	28,314,539	26 3	17 5	8 5	11,931,062
January 1916	2,449,518	26 1	17 10	7 10	962,120
February	2,297,276	26 8	18 4	8 0	924,310
March	2,455,019	26 5	18 1	8 0	979,234
April	2,291,231	26 10	18 2	8 4	951,247
May	2,382,298	26 7	18 2	8 2	977,263
June	2,296,520	27 0	18 3	8 6	977,681
July	2,370,244	26 1	17 10	8 0	949,606
August	2,423,669	26 3	17 10	8 1	976,125
September	2,367,793	26 6	18 0	8 3	972,704

Production of Gold in Rhodesia and West Africa.

	Rhodesia.		West Africa.	
	1915	1916	1915	1916
	£	£	£	£
January	293,133	318,586	143,649	140,579
February	286,879	313,769	144,034	137,739
March	299,686	335,368	153,770	150,987
April	315,541	339,386	149,978	135,976
May	318,898	323,783	142,123	132,976
June	322,473	333,070	135,289	127,107
July	336,565	322,365	140,290	128,574
August	344,493	338,001	139,364	125,143
September	321,085	322,035	135,744	127,138
October	339,967	325,608	141,771	132,577
November	313,160	—	122,138	
December	331,376		158,323	—
Total	3,823,166	3,271,974	1,706,473	1,338,796

Western Australian Gold Statistics.

	Reported for Export oz.	Delivered to Mint oz.	Total oz.	Total value £
January 1916	1,861	92,124	93,985	399,220
February	2,832	65,138	67,970	288,717
March	5,600	88,393	93,993	399,255
April	2,926	87,601	90,527	384,532
May	577	83,301	83,878	356,289
June	2,070	92,612	94,682	402,181
July	912	91,725	92,637	393,495
August	*	89,522	*	*
September	*	85,978	*	*
October	*	82,732	*	*
November	*	87,322	*	*

* By direction of the Federal Government the export figures will not be published until further notice.

Australian Gold Production.

	Victoria.		Queensland.		New South Wales
	1915	1916	1915	1916	1916
	£	£	£	£	£
January	69,900	89,900	43,770	66,700	39,000
February	122,300	76,500	85,850	79,050	30,000
March	142,800	103,600	98,550	76,920	36,000
April	109,300	60,000	97,320	83,300	63,000
May	102,900	119,500	130,470	116,230	19,000
June	134,200	86,000	90,500	72,200	18,000
July	154,800	100,600	88,830	85,400	23,000
August	80,300	66,800	93,050	86,000	24,000
September	138,900	115,100	79,470	65,450	32,000
October	111,700	81,400	91,800	74,800	32,000
November	115,300	—	77,780	—	—
December	115,400	—	81,170	—	—
Total	1,397,800	899,400	1,078,560	806,650	317,000

Production of Gold in India.

	1913	1914	1915	1916
	£	£	£	£
January	187,910	193,140	201,255	192,150
February	179,981	185,508	195,970	183,264
March	189,715	191,853	194,350	186,475
April	191,215	189,197	196,747	192,208
May	190,607	193,031	199,786	193,604
June	189,322	192,224	197,447	192,469
July	193,859	195,137	197,056	191,404
August	193,998	196,560	197,984	192,784
September	191,642	195,843	195,952	192,330
October	194,314	198,191	195,531	191,502
November	192,606	197,699	192,714	192,298
December	201,931	211,911	204,590	—
Total	2,299,315	2,340,259	2,366,457	2,100,488

Daily London Metal Prices

Copper, Lead, Zinc, Tin, in £ per long ton. Silver in pence per standard ounce.

	Copper, Standard	Copper, Electrolytic	Lead	Zinc	Tin, Standard	Silver
Nov.	£ s. d.	£	£ s. d	£ s. d.	£ s. d	d.
13	126 10 0	149	30 10 0	55 15 0	186 5 0	$34\frac{3}{16}$
14	128 10 0	152	30 10 0	56 0 0	187 15 0	$34\frac{3}{16}$
15	129 10 0	155	30 10 0	56 0 0	189 10 0	$34\frac{1}{16}$
16	134 10 0	155	30 10 0	56 15 0	189 0 0	34
17	139 0 0	158	30 10 0	57 10 0	188 17 6	34
20	141 0 0	160	30 10 0	56 10 0	188 10 0	$34\frac{3}{8}$
21	144 10 0	163	30 10 0	56 10 0	188 15 0	$34\frac{9}{16}$
22	144 10 0	165	30 10 0	57 5 0	191 0 0	$34\frac{13}{16}$
23	144 10 0	165	30 10 0	58 0 0	191 10 0	$34\frac{15}{16}$
24	144 10 0	166	30 10 0	58 0 0	190 5 0	$34\frac{15}{16}$
27	147 0 0	168	30 10 0	58 10 0	190 10 0	$35\frac{5}{16}$
28	145 10 0	169	30 10 0	59 0 0	190 0 0	$35\frac{5}{16}$
29	150 5 0	169	30 10 0	59 10 0	189 0 0	$35\frac{1}{2}$
30	151 0 0	169	30 10 0	59 10 0	189 5 0	$35\frac{15}{16}$
Dec.						
1	151 10 0	170	30 10 0	59 10 0	190 5 0	$35\frac{7}{8}$
4	151 10 0	170	30 10 0	60 0 0	189 5 0	$35\frac{13}{16}$
5	152 0 0	170	30 10 0	58 10 0	188 0 0	$36\frac{1}{16}$
6	153 0 0	170	30 10 0	58 0 0	187 0 0	$36\frac{1}{8}$
7	152 10 0	170	30 10 0	58 0 0	186 10 0	$36\frac{1}{8}$
8	151 10 0	171	30 10 0	*	*	$35\frac{15}{16}$
11	148 0 0	168	30 10 0	*	*	$36\frac{1}{8}$

* No quotations published.

Imports of Ores and Metals into United Kingdom.
Long tons.

	Year 1915	Oct. 1916	Nov. 1916	Year 1916 to-date
	Tons	Tons	Tons	Tons
Copper Ore	38,131	2,466	2,396	31,106
,, Matte and Precipitate	38,372	5,333	4,574	41,661
,, Metal (unwrought and part wrought)	180,368	7,057	8,616	102,336
Copper and Iron Pyrite	903,401	60,290	55,956	880,456
Tin Concentrate	44,748	4,184	1,792	32,063
,, Metal	38,896	2,016	3,402	32,014
Manganese Ore	377,324	38,360	32,850	419,604
Lead, Pig and Sheet	256,476	11,780	8,206	138,961
Zinc (spelter)	74,520	5,716	5,573	47,805
	lb.	lb.	lb.	lb.
Quicksilver	3,043,434	62,734	54,001	2,554,414

Stocks of Copper.
Reported by Henry R. Merton & Co. Ld. Long tons

	Sept. 30, 1916	Oct. 31 1916	Nov. 30, 1916
	Tons	Tons	Tons
Standard Copper in England	1,379	771	520
Fine Copper in England	1,783	2,397	4,958
,, ,, Havre	2,634	2,290	2,123
,, ,, Afloat from Chile	1,575	650	200
,, ,, ,, from Australia	3,000	4,000	4,000
Total Visible Supply	10,371	10,108	11,801
Fine Copper in Rotterdam	1,150	1,150	1,150
,, ,, Hamburg	2,867*	2,867*	2,867*
,, ,, Bremen	1,106*	1,106*	1,106*

* As on July 31, 1914, but presumably present stock nil.

Exports of Copper from United States
Reported by United States Customs.

1915	Long tons	1916	Long tons	1916	Long tons
July	16,812	January	21,863	July	35,048
August	16,289	February	20,548	August	34,700
September	14,327	March	24,006	September	28,572
October	26,153	April	19,980	October	32,712
November	19,396	May	14,700	November	21,433
December	32,936	June	38,277	December	—
Total 1915	257,915			Total 1916	291,839

Stocks of Tin.
Reported by A. Strauss & Co Long tons.

	Sept. 30, 1916	Oct. 31, 1916	Nov. 30, 1916
	Tons	Tons	Tons
Straits and Australian, Spot	1,652	2,201	2,014
Ditto, Landing and in Transit	1,360	657	1,648
Other Standard, Spot and Landing	1,018	887	1,048
Straits, Afloat	3,028	3,405	2,282
Australian, Afloat	265	225	250
Banca, on Warrants	—	—	—
Ditto, Afloat	840	1,904	3,934
Billiton, Spot	—	—	—
Ditto, Afloat	423	290	792
Straits, Spot in Holland and Hamburg	—	—	—
Ditto, Afloat to Continent	1,581*	1,400*	673*
Afloat for United States	3,000	4,433	6,260
Stock in America	4,769	3,419	2,850
Total Stock	17,933	18,821	21,751

* Including 200 tons on board enemy's ships either captured or lying in neutral ports

Shipments and Imports of Tin
Reported by A. Strauss & Co. Long tons.

	Year 1915	Oct. 1916	Nov. 1916	1916 to date
	Tons	Tons	Tons	Tons
Shipments from:				
Straits to U.K.	23,330	2,455	1,407	24,287
Straits to America	31,565	2,683	3,475	24,678
Straits to Continent	11,024	730	498	7,864
Australia to U.K.	2,481	100	315	2,337
U.K., Holland, and Continent to America	14,967	1,320	1,050	13,838
Imports of China Tin into U.K. and America	3,012	—	—	1,290
Imports of Bolivian Tin into Europe	22,591	2,700	1,225	14,487

Nigerian Tin Production.
In long tons of concentrate of unspecified content.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	204	466	485	417	531
February	240	427	469	358	528
March	247	510	502	418	547
April	141	430	482	444	486
May	144	360	480	357	536
June	121	321	460	373	510
July	140	357	432	455	506
August	201	406	228	438	498
September	196	422	289	442	535
October	256	480	272	511	561
November	340	446	283	467	—
December	310	478	326	533	—
Total	2,540	5,103	4,708	5,213	5,238

Production of Tin in Federated Malay States.
Estimated at 70% of Concentrate shipped to Smelters.

Long Tons.

	1912	1913	1914	1915	1916
	Tons	Tons	Tons	Tons	Tons
January	4,022	4,121	4,983	4,395	4,316
February	4,318	3,823	3,555	3,780	3,372
March	3,196	3,562	3,839	3,653	3,696
April	3,904	4,066	4,087	3,619	3,177
May	4,277	4,319	4,135	3,823	3,729
June	3,472	3,993	4,303	4,048	3,435
July	4,234	4,245	4,582	3,544	3,517
August	4,454	4,620	3,591	4,046	3,732
September	4,115	4,379	3,623	3,932	3,636
October	3,905	4,409	3,908	3,797	3,681
November	4,112	3,976	4,085	4,059	3,635
December	4,241	4,614	4,351	4,071	—
	48,250	50,127	49,042	46,767	39,926

Sale of Tin Concentrate at Redruth Ticketings.

	Long tons	Value	Average
Year 1915	5089½	£461,770	£90 14 6
January 3, 1916	157	£14,934	£95 2 6
January 17	186½	£18,122	£97 6 1
January 31	181	£18,023	£99 11 7
February 14	179½	£18,343	£102 6 7
February 28	181	£18,882	£104 6 5
March 13	182	£19,921	£109 9 2
March 27	190½	£21,437	£112 10 6
April 10	185½	£21,517	£115 19 11
April 25	164	£18,504	£112 16 7
May 8	181	£20,852	£115 4 2
May 22	190	£20,986	£110 9 0
June 5	175	£18,286	£104 9 10
June 19	182	£18,204	£100 0 6
July 3	179	£17,477	£97 12 10
July 17	186½	£17,114	£91 15 4
July 31	172½	£16,172	£93 17 8
August 14	166	£15,955	£96 2 4
August 28	180½	£17,345	£96 4 8
September 11	184	£17,113	£93 0 2
September 25	166½	£15,980	£95 19 7
October 9	197	£19,443	£98 13 11
October 23	170	£17,167	£100 19 9
November 8	191½	£19,701	£101 5 10
November 20	172	£18,044	£104 18 2
December 4	160½	£16,588	£105 4 6

SHARE QUOTATIONS

Shares are £1 par value except where otherwise noted.

GOLD, SILVER, DIAMONDS:	Dec. 6. 1915 £	s.	d.	Dec. 5. 1916 £	s.	d.
RAND:						
Bantjes		[illegible]	0		15	3
Brakpan	[illegible]	8	9	5	0	0
Central Mining (£8)	6	10	0	7	0	0
Cinderella		5	0		6	0
City & Suburban (£4)	2	4	6	1	17	6
City Deep	3	12	6	4	5	6
Consolidated Gold Fields	1	9	6	1	10	6
Consolidated Langlaagte	1	17	0	1	8	9
Consolidated Main Reef	1	0	0		18	6
Consolidated Mines Selection (10s)		13	6	1	3	6
Crown Mines (10s.)	3	8	9	3	0	0
Daggafontein		9	0		15	3
D. Roodepoort Deep		15	0		12	0
East Rand Proprietary	1	4	6		14	6
Ferreira Deep	2	0	0	1	5	0
Geduld	1	17	0	1	4	0
Geldenhuis Deep	1	0	0	1	2	6
Gov't Gold Mining Areas	1	10	6	2	11	3
Heriot	3	2	6	2	11	3
Jupiter		6	9		7	6
Kleinfontein	1	5	0	1	7	6
Knight Central		11	9		10	9
Knight's Deep	1	10	0	1	6	3
Langlaagte Estate		19	0		17	0
Luipaard's Vlei		8	6		8	6
Main Reef West		6	6		5	0
Meyer & Charlton	5	15	0	5	11	3
Modderfontein (£4)	15	3	9	18	16	3
Modderfontein B	6	0	0	7	5	0
Modder Deep	5	13	9	7	7	6
Nourse	1	0	0	1	0	0
Rand Mines (5s.)	4	8	0	3	12	6
Rand Selection Corporation	2	10	0	3	16	3
Randfontein Central		12	6		11	6
Robinson (£5)	1	6	3		17	6
Robinson Deep	1	3	9	1	15	0
Rose Deep	1	12	6	1	1	3
Simmer & Jack		9	9		6	9
Simmer Deep		2	9		4	6
Springs	1	16	3	3	3	9
Van Ryn	2	14	6	1	19	6
Van Ryn Deep	2	17	6	3	9	6
Village Deep	1	16	3	1	10	0
Village Main Reef	1	3	0		16	6
Witwatersrand (Knight's)	2	18	9	2	13	9
Witwatersrand Deep	1	10	0	1	1	9
Wolhuter		12	0		10	9
OTHER TRANSVAAL GOLD MINES:						
Glynn's Lydenburg		8	9		15	0
Sheba (5s.)		2	9		1	9
Transvaal Gold Mining Estates	1	7	0		19	6
DIAMONDS IN SOUTH AFRICA:						
De Beers Deferred (£2 10s.)	11	10	0	13	10	0
Jagersfontein	3	2	6	4	8	9
Premier Defer'd (2s. 6d.)	4	17	6	7	2	6
RHODESIA:						
Cam & Motor		14	9		11	6
Chartered British South African		11	6		11	0
Eldorado		11	9		8	3
Enterprise		6	0		5	0
Falcon		8	9		14	9
Giant		7	3		7	3
Globe & Phœnix (5s.)	1	6	6	1	17	6
Lonely Reef	1	3	9		18	6
Shamva	1	19	6		19	6
Wanderer (5s.)		1	0		1	3
Willoughby's (10s.)		5	6		4	0
WEST AFRICA:						
Abbontiakoon (10s.)		7	6		5	0
Abosso		8	6		8	6
Ashanti (4s.)		18	0		19	3
Prestea Block A		8	6		7	0
Taquah		15	0		17	6
WEST AUSTRALIA:						
Associated Gold Mines		6	6		4	0
Associated Northern Blocks		5	6		3	0
Bullfinch		5	9		3	0
Golden Horse-Shoe (£5)	2	0	0	1	17	0
Great Boulder Proprietary (2s.)		15	9		12	0
Great Boulder Perseverance			9			6
Great Fingall (10s).		1	9		1	3
Ivanhoe (£5)	2	5	0	2	2	6
Kalgurli		15	6		10	6
Sons of Gwalia		17	0		14	3

GOLD, SILVER, *cont.*	Dec. 6. 1915 £	s.	d.	Dec. 5. 1916 £	s.	d.
OTHERS IN AUSTRALASIA:						
Blackwater, New Zealand		15	0		12	0
Consolidated Gold Fields of N.Z.		11	3		5	0
Mount Boppy, New South Wales		10	0		7	6
Progress, New Zealand		5	0		2	6
Talisman, New Zealand		15	6		10	0
Waihi, New Zealand	1	15	6	1	15	0
Waihi Grand Junction, New Z'lnd	1	0	6		15	9
AMERICA:						
Alaska Treadwell (£5), Alaska	6	12	6	2	15	0
Buena Tierra, Mexico		13	9		12	0
Camp Bird, Colorado		8	6		6	6
Canadian Mining, Ontario		10	9		12	9
Casey Cobalt, Ontario		7	0		5	6
El Oro, Mexico		10	3		7	6
Esperanza, Mexico		10	9		9	9
Frontino & Bolivia, Colombia		9	0		12	6
Le Roi No. 2 (£5), British Columbia		10	6		9	6
Mexico Mines of El Oro, Mexico	4	3	9	3	10	0
Oroville Dredging, California		14	3		15	9
Plymouth Consolidated, California		18	0	1	0	0
St. John del Rey, Brazil		16	6		16	3
Santa Gertrudis, Mexico		10	6		9	0
Tomboy, Colorado	1	4	6	1	1	3
RUSSIA:						
Lena Goldfields	1	10	0	1	13	9
Orsk Priority		8	9	1	1	3
INDIA:						
Champion Reef (2s. 6d.)		10	0		6	6
Mysore (10s.)	4	0	0	3	8	9
Nundydroog (10s.)	1	6	0	1	5	6
Ooregum (10s.)	1	3	9	1	0	6

COPPER:

Anaconda (£10), Montana	18	7	6	21	7	6
Arizona Copper (5s.), Arizona	1	12	0	2	6	3
Cape Copper (£2), Cape Province	2	10	0	4	15	0
Chillagoe (10s.), Queensland			6			3
Cordoba (5s.), Spain		3	9		4	0
Great Cobar (£5), N.S.W.		3	3		2	3
Hampden Cloncurry, Queensland	1	8	6	1	15	3
Kyshtim, Russia	1	18	0	2	6	3
Messina (5s.), Transvaal		12	0		10	0
Mount Elliott (£5), Queensland	2	15	0	6	0	0
Mount Lyell, Tasmania	1	5	0	1	6	0
Mount Morgan, Queensland	2	0	0	1	12	0
Rio Tinto (£5), Spain	54	10	0	64	5	0
Sissert, Russia	1	0	0	1	3	9
Spassky, Russia	1	18	9	1	17	6
Tanalyk, Russia	1	15	0	2	10	0
Tanganyika, Congo and Rhodesia	1	17	6	2	10	6

LEAD-ZINC:

BROKEN HILL:						
Amalgamated Zinc	1	7	6	1	11	6
British Broken Hill	1	2	6	1	6	6
Broken Hill Proprietary (8s.)	2	9	3	2	12	6
Broken Hill Block 10 (£10)		19	6	1	0	3
Broken Hill North	2	3	6	2	8	6
Broken Hill South	7	2	6	8	15	0
Sulphide Corporation (15s.)	1	3	9	1	9	9
Zinc Corporation (10s.)		14	0		15	6
ASIA:						
Burma Corporation	1	13	9	3	10	0
Irtysh Corporation	1	16	3	2	0	0
Russian Mining		15	6		16	3
Russo-Asiatic	4	10	0	4	17	6

TIN:

Aramayo Francke, Bolivia	1	7	6	1	7	6
Bisichi, Nigeria		6	0		12	0
Briseis, Tasmania		5	0		5	0
Dolcoath, Cornwall		6	0		9	9
East Pool, Cornwall		9	0	1	13	9
Ex-Lands Nigeria (2s.), Nigeria		1	0		1	6
Gopeng, Malay	1	8	9	1	10	0
Malayan Tin Dredging, Malay	1	11	3	2	0	0
Mongu (10s.), Nigeria		8	9		9	6
Naraguta, Nigeria		12	6		14	6
N. Nigeria Bauchi (10s.), Nigeria		1	6		3	0
Pahang Consolidated (5s.), Malay		7	6		10	9
Rayfield, Nigeria		4	0		7	6
Renong Dredging, Siam	1	6	3	2	2	0
Ropp (4s.), Nigeria		13	0		17	6
Siamese Tin, Siam	2	13	9	2	10	0
South Crofty (5s.), Cornwall		4	9		14	6
Tekka, Malay	2	12	6	3	5	0
Tronoh, Malay	1	10	0	1	12	3

THE MINING DIGEST

A RECORD OF PROGRESS IN MINING, METALLURGY, AND GEOLOGY

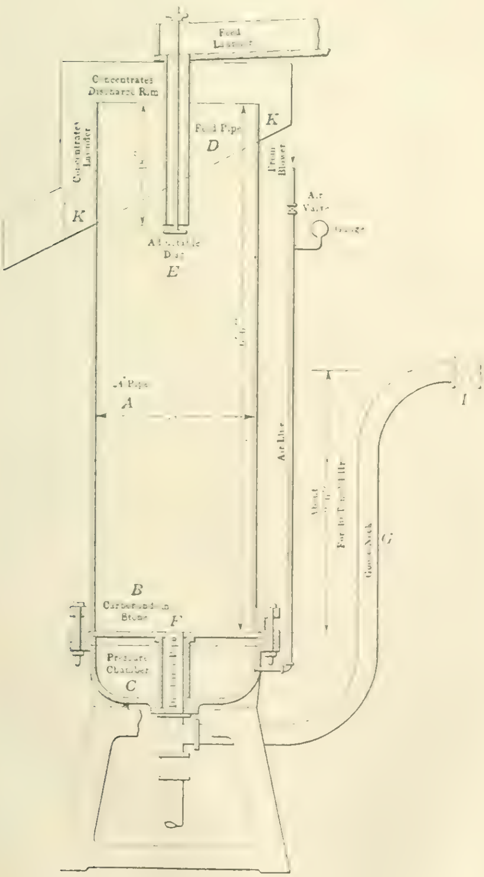
In this section we give abstracts of important articles and papers appearing in technical journals and proceedings of societies, together with brief records of other articles and papers; also reviews of new books, and abstracts of the yearly reports of mining companies.

RISING BUBBLES IN FLOTATION.

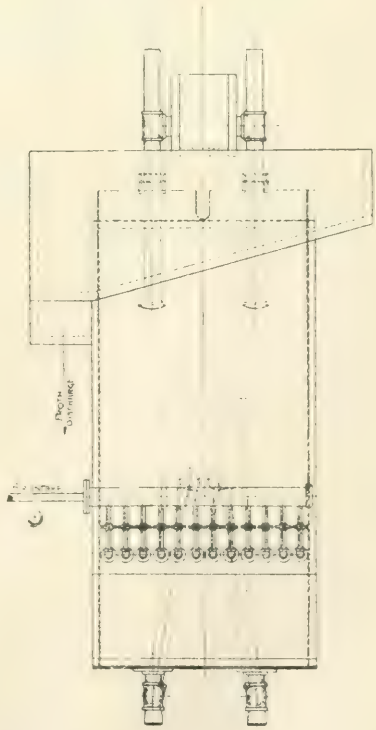
In the west of America, flotation experiments and practice have largely centred round the method of introducing the air-bubbles from the bottom, as distinct from the method of introduction by rapid agitation adopted in the standard Minerals Separation machine Of the various processes, that invented by J. M. Callow, and adopted at Miami and elsewhere, has been the most prominent. We described this process in our issue of January last. Three other methods based on the same principle have been tried, known as the Flinn-Towne, the Cole-Bergman or "C-B," and the Inspiration, respectively. Information is given relating to these in papers published in the September *Bulletin* of the American Institute of Mining Engineers entitled: "Flotation in the Clifton-Morenci District, Arizona," by David Cole, and "History of the Flotation Process at Inspiration," by Rudolf Gahl.

A Flinn-Towne plant was erected at the Teziutlan copper mine, 130 miles southeast of Mexico City, but political troubles prevented it from being brought into use. The machine was tested at the Inspiration and other mines in Arizona. This machine consists of a vertical cylinder having a bottom of porous brick, preferably made of carborundum. The compressed air is introduced into the pulp through this brick. Experimenters in Arizona found that the bricks became clogged easily and had often to be removed and cleaned.

David Cole, of the Arizona Copper Company, in experimenting on flotation, placed perforated iron pipes side by side at the bottom of a wooden box, and introduced the compressed air through these pipes. He found that the amount of air introduced was much greater than was the case with Callow matting or Flinn-Towne brick, the reason no doubt being that the total



THE FLINN-TOWNE MACHINE.



THE COLE-BERGMAN MACHINE.

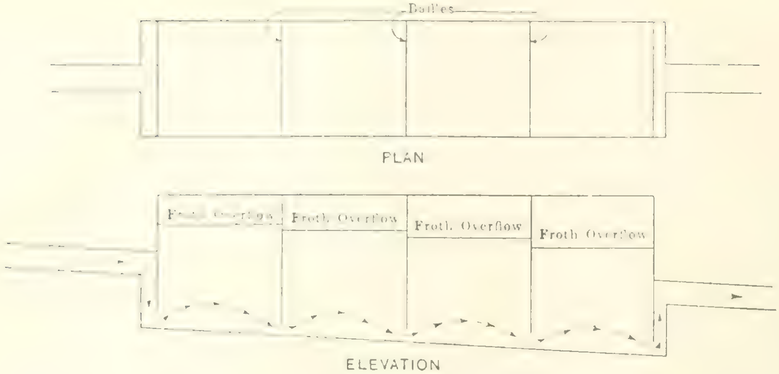
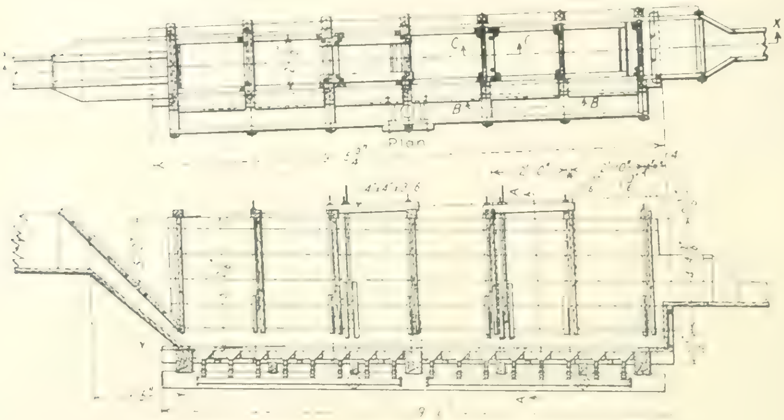


DIAGRAM EXPLAINING THE PRINCIPLE OF THE INSPIRATION METHOD.



PLAN AND LONGITUDINAL SECTION OF THE INSPIRATION CELL.

area of surface of the tubes is greater than the flat surface of the matting or brick. On the other hand the iron is easily corroded by the acid waters usually found in sulphide-ore mines.

At the Inspiration mine, the Flinn-Towne, the Cole-Bergman, and the Callow plants were tried competitively. Eventually a modification of the Callow plant was adopted, the improvement consisting of the use of transverse baffles which cause the pulp to pass from one division of the cell to the next through apertures below the baffles. The object of these baffles is to prevent sulphide froth from passing over with the tailing. In this connection it is of interest to refer to the description of Hyde's modification of the Callow cell in our September issue. While writing of the use of the upward flow of air bubbles, it may be well to remind readers that the Hebbard modification of the Minerals Separation plant provides for the introduction of air at the bottom of the cells as well as the creation of froth by rapid agitation with impellers. This type of machine as applied at Anaconda was described in our issue of July last. The introduction of air at the bottom of a flotation machine was described by T. J. Hoover in his British patent 10,929 of 1910, which belongs to the Minerals Separation company. However, the rising and expanding bubble was used as far back as 1904 in the Elmore vacuum plant. We discuss this matter in our editorial pages.

PRECIPITATING SILVER BY SODIUM SULPHIDE.

In our issues of April and May 1915 we quoted an account of some experiments made by W. R. Feldtmann in connection with the use of sodium sulphide as a precipitant of precious metal from cyanide solutions. We are informed that, though this process was not found advantageous at Mr. Feldtmann's mine, the Ashanti, it has been applied with satisfactory results at Prestea Block A by H. F. Marriott and F. Wartenweiler. No information has as yet been published with regard to the practice at Prestea. In the meantime, other metallurgists have applied this precipitant, and R. B. Watson has published his results obtained with silver at the Nipissing mine at Cobalt. His paper is published in the November *Bulletin* of the Canadian Mining Institute.

It will be remembered that at the Nipissing mine aluminium dust and caustic soda were introduced as a substitute for zinc for the purpose of precipitating silver from cyanide solution. We described this process in our issues of June 1913 and October 1915. Since the war began, the prices of aluminium and caustic soda have advanced. It was not desirable to employ zinc any way on account of the deleterious action of certain constituents of the solution, notably arsenic and zinc itself. The use of sodium sulphide appeared to provide the most promising means of escape from the difficulty; and the experiments carried out by J. J. Denny were so satisfactory that in June 1916 this process was adopted.

Mr. Hamilton had suggested two objections to the use of sodium sulphide for this purpose: one, that complete precipitation could not be obtained without using an excess of the reagent; and the other, the difficulty of producing silver sulphide instead of metallic silver. As regards the first point, it was found in practice that the solution could be precipitated to 0·2 oz. silver without showing an excess of sodium sulphide in the barren solution. The second objection was met by coverting the silver sulphide to bullion by using the principle employed in the desulphurization of the raw ore before it is sent to cyanide treatment. This principle is that the various sulphide combinations of silver are decomposed by contact with metallic aluminium in a caustic soda solution. Its successful application to the treatment of Nipissing ores was worked out by J. J. Denny. This method was described in the Magazine for October 1913. This is the important feature of the process, since it gives fine bullion as a final product at a small cost.

The reactions involved are as follows:

1.—$2\ Na\,Ag\,Cy_2 + Na_2S = Ag_2S + 4\ Na\,Cy.$
2.—$2\ Al + 5\ Na\,OH + 3\ Ag_2S = Na_2Al_2O_4 + 6\ Ag + 3\ NaHS + H_2O.$
3.—$2\ Al + 8\ Na\,OH + 3\ Ag_2S = Na_2Al_2O_4 + 3\ Na_2S + 6\ Ag + 4\ H_2O.$

The commercial sodium sulphide used is supposed to be $Na_2S + 9\ H_2O$; this would be equivalent to 32·5% Na_2S. A concentrated form of sodium sulphide can be obtained, which promises to work out cheaper than the ordinary brand.

By equation (1) it would require 0·076 lb. of commercial sodium sulphide to precipitate one troy ounce of silver. In practice the amount required is 0·12 lb. In the desulphurizing operation as shown in equation (2) one troy ounce of silver requires 0·021 lb. of NaOH. This would be 0·028 lb. of commercial caustic soda carrying 76% NaOH. If an excess of caustic is present in the operation, the reaction shown in (3) is apt to take place, in which case 0·034 lb. of NaOH is used for each ounce of silver desulphurized. To prevent this taking place, the amount of silver present in the charge to be desulphurized is estimated as closely as possible and 0·03 lb. of commercial caustic soda is added for each ounce of silver contained.

The theoretical amount of aluminium necessary to desulphurize one ounce of silver is 0·0057 lb.; the amount actually used in practice is 0·006 lb.

The sodium sulphide is dissolved in an iron barrel, 2 ft. 6 in. in diam. by 4 ft. deep, into which is flowing constantly a small stream of barren solution from the filter-press. The barrel is divided by a vertical partition reaching nearly to the bottom. There is an excess of sodium sulphide in the barrel, and the overflow pipe on the other side of the partition from the inflow carries the precipitant to a vat, 5 ft. in diameter by 6 ft. deep, where it is agitated with the pregnant solution, which is then pumped to the Merrill filter-press. The amount of sodium sulphide added is regulated by a boy, who constantly tests the inflowing barren solution with pregnant solution and with sodium sulphide to determine whether there is an excess of sodium sulphide or unprecipitated silver present in the discharge from the press. The amount of barren solution coming into the barrel, and consequently the overflow of sodium sulphide, is regulated by a valve on the intake pipe in front of the operator. This operation could be carried out more precisely, perhaps, by precipitating a vatful at a time; but in this case, the vat capacity was not available. The solution from the filter-press is aerated thoroughly in the barren solution vat by air-lifts and a large circulating pump, the object being to oxidize any sodium sulphide, should there happen to be a slight excess in the precipitated solution. The shift man always tests the solution for soluble sulphide before running it to the treatment vats, and no bad effects have been noticed from this cause. Aeration is used in preference to lead salts, as lead has a bad effect on extraction.

A pressful of sulphide precipitate contains 25,000 oz. of silver. This is thrown into a vat 7 ft. in diam. by 5 ft. deep and the proper amount of caustic soda is added, figuring 0·03 lb. for each ounce of silver; the dilution is 4 parts of solution to 1 of sulphide; the strength of the solution in NaOH is about 8%. The pulp in the vat is kept mixed by the usual mechanical stirring device. Over this vat is mounted a small tube-mill, 15 in. in diameter by 6 ft. long, which makes 10 revolutions per minute. The charge of aluminium ingots weighs 300 lb. and fills the tube-mill half full. Below the vat is a centrifugal pump which circulates the pulp from the tank and through the tube-mill for 10 or 12 hours. When the desulphurization is about complete the precipitate rubbed on a piece of paper by a spatula gives a silvery colour and a metallic lustre. It is then pumped to another press where it is washed for two hours; the resulting product is mixed with a small amount of borax, charged without drying into a reverberatory refining furnace, and melted down to bullion 996 fine.

The grade of the precipitate depends largely on how well the pregnant solution has been clarified before precipitation, but under ordinary conditions it assays about 23,500 oz. before and 26,500 oz. after desulphurization. The final product carries from ½% to 1% sulphur. Gold is not precipitated in an alkaline cyanide solution, and copper does not come down if there is sufficient free cyanide in the solution.

Considering the present war price of aluminium dust, the continued use of this reagent for precipitation is out of the question. It would appear, however, that even when prices of all chemicals used return to normal, sodium sulphide precipitation will be cheaper.

In the following comparison, pre-war prices are given; the quantity of aluminium dust used per ounce silver is the average for 1915.

	cents per oz. silver	
ALUMINIUM DUST METHOD:		
0·0262 lb. Aluminium dust at 33·82c	0·8861	
0·05 „ Caustic Soda at 2·11c	0·1055	
Labour, power and workshops	0·1710	
		1·1626
SODIUM SULPHIDE METHOD:		
0·12 lb. Commercial Sodium Sulphide	0·2268	
at 1·89c	0·2268	
0·006 „ Aluminium Ingots at 19·25c	0·1155	
0·03 „ Caustic Soda at 2·11c	0·0633	
Labour, power and workshops	0·3020	0·7076
DIFFERENCE in favour of Na_2S method		0·4550c

Saving per year: 2,000,000 ounces at ·455c = $9,100.

It has been shown in Mr. Hamilton's article that a large part of the saving in the use of aluminium over zinc dust is in the regeneration of cyanide. The regeneration is the same when sodium sulphide is used.

The process as above described is limited in its application to silver ores, as gold sulphide is not precipitated. It is possible, however, that the above procedure could be used to precipitate the silver, followed by the precipitation of the gold by aluminium.

TRANSPORTING IRON FROM IRON KNOB.

The iron ore deposits worked by the Broken Hill Proprietary are on Iron Knob and Iron Monarch hills, 1160 ft. above sea level and 34 miles northwest of the company's port at Hummock Hill on Spencer Gulf, nearly opposite Port Pirie, South Australia. There is no natural harbour and the steamers which carry the ore to Newcastle, New South Wales, have to load from a jetty 2290 ft. in length. The ore is carried along the jetty on conveyor belts, particulars of which are given later. A full illustrated description of the method of transport from mine to steamer is given in the *Mining and Engineering Review*, of Melbourne, for September.

The quarries are at the top of the hills, and the ore is delivered in 6 ton cars down inclines from each quarry to a main gravity incline. Four cars (or less) are lowered together down the main incline, and their contents discharged into a bin 150 by 20 by 20 ft. From this bin the ore is fed into cars of 10 and 15 tons capacity running on a tramway of 3 ft. 6 in. gauge. These cars are made up in trains carrying 330 to 350 tons of ore, and hauled by steam locomotive to Hummock Hill. Here the ore is discharged into bins from which it is fed to jaw-crushing plant set to an aperture of 3½ in. The crushed ore is delivered into receiving bins placed below each crusher. A rubber conveyor belt, 26 in. wide and 220 ft. between centres is fitted under these bins, and the ore is discharged on to the belt from the crusher bins. Near the discharging end, the belt rises to a vertical height of 12 ft. at an angle of 15°, and discharges the ore on to a cross belt of the same size running at right angles, which in turn discharges the ore on to the conveyor-belt leading to the main storage bin. All these belts travel at 350 ft. per minute, and are fitted with trough rollers on the loaded and flat rollers on the return side. The storage bin is an excavation 350 ft. long with sloping sides. At the bottom the sides are vertical and are reinforced with strong concrete walls 2 ft. 6 in. thick by 6 ft. vertical, on which a floor of steel troughing ⅝ in. thick is laid transversely, each section being rivetted to the next with ¾ in. rivets at 4 in. pitch At intervals of 10 ft. suitable openings are cut in the troughing, and discharge chutes are fixed to deliver the crushed ore from the bin on to a 36 in. conveyor belt extending the full length of the bin, in a tunnel underneath. Each chute is capable of discharging 1400 tons per hour, but only one chute is operated at a time. The total storage capacity of this bin is 30,000 tons.

The conveying plant to transmit this ore to the steamers consists of a set of seven conveyor belts 36 in. in width and ¾ in. thick, discharging from one to the other until the end of the jetty is reached. Six of these belts are 400 ft. between centres. Each of the belts is elevated near the discharge end at an angle of 15°, sufficiently high to provide sufficient discharge room to the next belt. The ore is transferred by means of suitable steel chutes from one belt to the other. All chutes are lined with hard iron wearing plates to provide against the abnormal wear due to abrasion. The last section of the belt is elevated at an angle of 15° to a vertical height of 25 ft., and discharges on to a short 36 in. belt with 65 ft. centres. This belt is fitted on a steel boom. The boom is fitted with track wheels and is so arranged as to move out over the vessel's hold to a distance of 28 ft. The vertical rise of No. 7 conveyor belt is necessary to provide sufficient head room for loading large empty vessels. The boom is a steel lattice-work structure of the cantilever type, 70 ft. long, running on rails, and is propelled forward or backward by means of a capstan winch. The distance this boom can be moved forward is ample to reach the centre of the steamer's hold. A swinging chute, 10 ft. long, is attached to the end of the boom, which can be lowered into the ship's hold if desired. The rated capacity of the belts is 1000 tons per hour, and this tonnage has been conveyed without difficulty. The electric power to drive the belts and the crushers is supplied by a portable steam engine of 600 brake-horse-power, coupled direct to a 420 hp. alternator. Coal for the steam engine and for the tramway is brought in the steamers on their return journey from Newcastle, New South Wales.

OIL-SHALES IN NATAL.

A report has been made by A. L. Du Toit for the South African Geological Survey on the oil-shales of Impendhle county, Natal. These shales are found at the head of the Loteni and Umkomaas rivers, about 50 miles west of Pietermaritzburg, and in the foot hills of the Drakensberg to the south of Giant's Castle. It will be remembered that in 1913, the Union Government commissioned E. H. Cunningham Craig to report on the possibilities of finding petroleum in South Africa. We gave an outline of his views in our issue of April 1913. The only bright spot mentioned by him was the oil-shale occurrence in Natal. The Union Government took his advice and Mr. Du Toit was instructed to make a detailed survey. We quote from Mr. Du Toit's report in the following paragraphs.

The sub-division of the Karroo System to which the oil shale belongs is that of the Molteno beds, and the horizon is therefore much higher than that of the coal-seams of Natal. The Molteno beds here are not more than 400 ft. in thickness, and are distinguished from the underlying Beaufort beds by the characteristic coarse-grained nature of the thick bands of sandstone, these carrying small pebbles of white quartz and having a peculiar sparkling appearance under the rays of the sun. Such characters serve to distinguish this formation in the field at once. The first or lowest of these sandstones is one which has been traced almost continuously from the Stormberg area, and is known as the Indwe sandstone, while just above it comes the horizon of the oil-shale. About 60 ft. higher up lies the second bed of grit, a zone which is usually a little more prominent than the first. Sandwiched thus between these two sandstones, the oil-shale zone can be followed without difficulty along the flanks of the spurs, even when the continuity of the outcrops is interrupted by fallen material or dislocated by dolerite intrusions.

The strata immediately above the oil-shale consists of bluish-grey mud-stones which pass upward into reddish mudstones; this fact also aids in picking up the horizon and determining the exact level at which an adit should be placed. From its position immediately above the Indwe sandstone, the oil-shale is to be correlated with the coal-seams at Molteno, Cyphergat, Gubenxa, etc., in the Cape. This is confirmed by the presence of a soft shaly roof and by the fact that the layers of bituminous matter are generally parted by or rest upon fireclay, just as so often happens in the

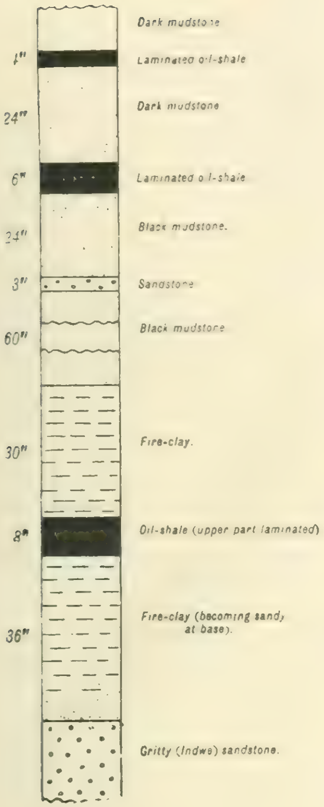


FIG. 1.

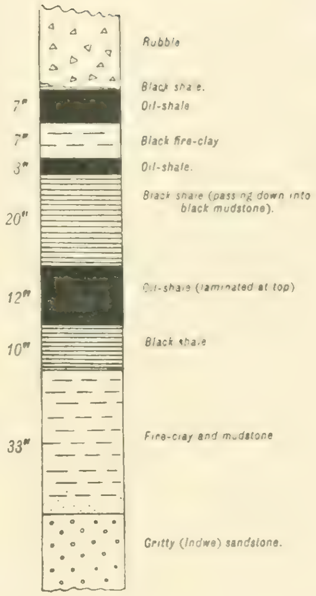


FIG. 2.

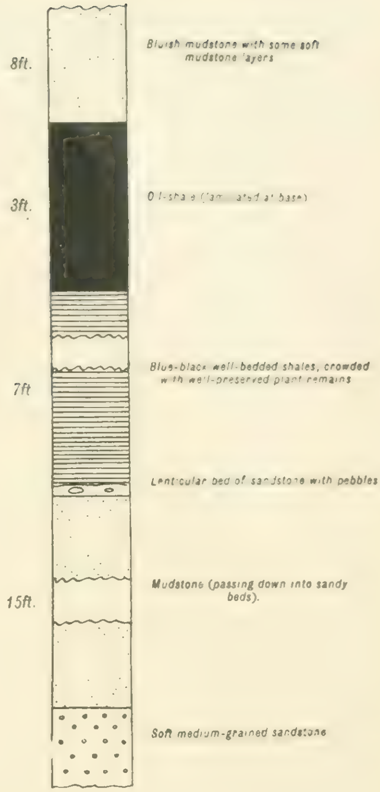


FIG. 3.

CHARACTERISTIC SECTIONS OF NATAL OIL-SHALES.

case of the thin coals in the Stormberg. Although the horizon of the oil-shale can always be located with considerable accuracy along the flanks of the spurs, it is only here and there that the material is actually exposed, either naturally or by trenches. In certain places its presence is indicated by fragments of the bituminous material on the slopes or in the soil, while in other spots it is altogether absent. The sections which Mr. Du Toit describes show considerable variation from point to point and there is evidence sometimes of a rapid lateral change in character of the compound seam. The seam consists of 10 or 15 ft. of fireclay, mudstone, and dark carbonaceous shale, with one or more layers of a bituminous nature and almost like a cannel coal, which when broken across the bedding planes shows a dull brownish-black amorphous material with numerous thin laminae of shiny black coal. It is tough and resists weathering rather well, so that fragments are found along the outcrop or even at some distance away down the slopes. The specific gravities of two samples, the first of which was taken from a natural exposure, were 1·938 and 1·916. These figures are very much higher than those for steam coals in general, and still more so than those of the cannels and gas-coals. The term oil-shale, though a misnomer, has been given to bituminous stuff of this nature, and has to be employed for want of a more appropriate designation. The better grades are uniform in character and compact, and pass insensibly into types which are poorer in bituminous matter and are to be distinguished by their more laminated character and higher specific gravity; both varieties, however, will yield oily products upon destructive distillation. The lower grade material is termed laminated oil-shale, as at the weathered outcrop it splits up readily into thin but tough laminae. Finally, this stuff passes into black carbonaceous and often sandy shales and mudstones, which when exposed to the weather, crumble into irregular fragments and bleach to a dark blue or pale blue tint; such a rock will be of no economic value whatever. The individual seams are nearly always thin, and only in two sections described by the author is there a total thickness of at least 2 ft. of oil-shale; the field is also limited by the presence of intrusive dolerite on or near the oil-shale horizon.

At Oorpoort there is a well exposed section, shown in Fig. 1, in which three small seams of oil-shale appear, but owing to the distance between the bottom and the middle seam, it would be impossible to work the lot. This area is spoilt by the 50 ft. sheet of dolerite which, overlying the oil-shale here, cuts through the shale twice a little farther up the ravine. At Glenara the oil-shale is well seen below a little waterfall, though the sides of the cutting have slipped in somewhat; this is the place from which Mr. Cunningham Craig reported a thickness of seam of 5 ft., of which 3 ft. seemed to him to be of sufficiently good quality to be worth mining. The section is shown in No. 2, from which it will be seen that there are three seams of 7, 3, and 12 inches respectively, and very probably a part or the whole of the 10 inches of black shale beneath the lowest seam could be included, subject to the favourable result of an analysis.

The most important exposure is that below a waterfall on Crown lands on the right of the Umkomaas valley, the spot being locally known as Forder's Coal Mine; it is situated in the angle of an irregular amphitheatre walled in by cliffs of Molteno grits. A full section of the lower half of the Molteno beds is exposed in the gully, the important part of which is figured in Fig. 3 The seam of oil-shale forms a single layer exactly 3 ft. in thickness resting upon 7 ft. of dark blue-black shales and overlain by 8 ft. of bluish mudstones, and these in turn by soft red-coloured rocks. The oil-shale is remarkably uniform in quality; it becomes more stony toward the extreme base, but possibly even another inch or two could be reckoned upon for purposes of distillation. It was from this exposure that the sample taken by Mr. Redmayne came, which gave on analysis a yield of 27·1 gallons of oil to the ton, as quoted by Mr. Cunningham Craig; the occurrence is obviously therefore one worthy of detailed geological consideration.

In conclusion, it is pointed out that it is imperative first of all to prove the continuity of the seam over an area of half a square mile at least, preferably in one or both of the localities in Figs. 2 and 3; and, secondly, as recommended by Mr. Cunningham Craig, to extract one or more samples of several tons of fresh shale representative of the seam, upon which a thorough commercial test might be made. The Impendhle county suffers by reason of its geographical difficulties, while the oil-shales in the region are neither rich nor thick; but the deposits have only been tested in a very casual and incomplete manner hitherto and in fairness deserve further consideration.

THE HALL OIL-CRACKING PROCESS.

In a paper read before the Institution of Petroleum Technologists on November 21, giving a historical account of work done in connection with the production of hydrocarbons by cracking and synthesis, E. L. Lomax, A. E. Dunstan, and F. B. Thole referred incidentally to the Hall process for cracking petroleum and producing motor spirit and the aromatic compounds. The authors are of opinion that the Hall process, which has been modified from time to time as experience has been gained, is one of the most, if not the most, successful of those being worked. In the process as at present worked the oil to be treated is passed through a continuous coil of about 600 ft. of cold-drawn tubing of 1 in. internal diameter, at temperatures and pressures which vary according to the desired product. The oil fed in at the cooler end of the retort is gradually heated and vapourized, the speed of the vapours being about 5000 to 6000 ft. in the latter portion of the coil, and where the temperature is highest. At the exit, the vapours are suddenly expanded into a tube of much larger diameter, down to atmospheric pressure. Here an appreciable rise in temperature is experienced without external aid, due partly to transformation of the kinetic energy of the high velocity gases into heat, and partly to the disruption of the molecules of the oil. It is at this point that most of the cracking takes place, and a little graphitic carbon is formed. The vapours now pass through a series of dephlegmators, built on the Raschig principle. In the first one of these, a little soft spongy carbon and pitch separates out; in the second a heavy residue free from pitch, and in the third one, a very light mobile residue. The vapours, cooled now to about 100° C., pass to compressors, which having already expanded the gas on exit from the converter tubes down to atmospheric pressure, now compress the wet vapours, which are cooled and stored under a pressure of 50 to 75 lb. per square inch.

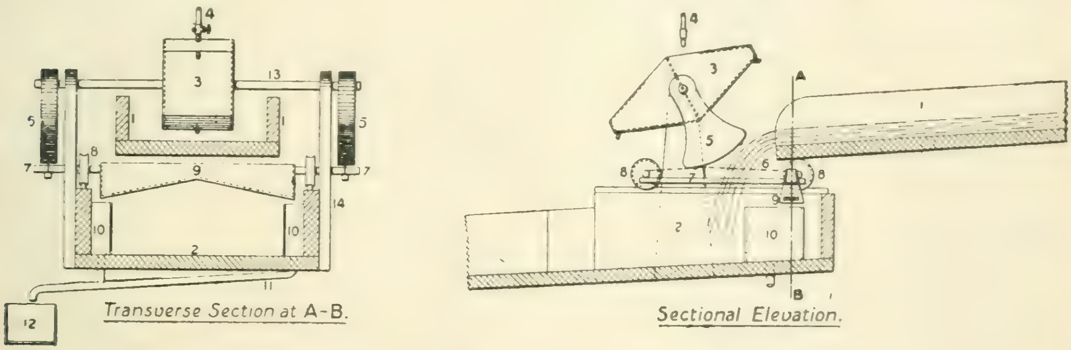
A peculiar reaction has been noticed in these compressors when working for motor spirit. As a rule, when gases are compressed, the temperature rises, but in the case of these gases, the temperature falls slightly after compression, which fall can only be caused by chemical combination, or polymerization of some of the lighter hydrocarbons, as it is well known that some of the hydrocarbons produced in cracking oil polymerize very readily even at ordinary temperatures and pressures. By re-running the residues from the second and third dephlegmators, yields of 70% of motor spirit from the original oil used have been obtained. In working for motor-spirit, the temperature at the exit of the tubes is about 550 to 600° C., a temperature which requires varying between these limits according to the oil being cracked; but when once the best temperature for any particular oil has been decided, this temperature can be most rigidly adhered to, variations of plus or minus 5° C. being the extremes over periods of several hours working. This complete control of the temperature is an important consideration in a process of thermal decomposition, as, at the temperatures employed, the thermal coefficient is very high, and comparatively small variations give rise to very divergent results. This is a point, by the way, to which many inventors have failed to pay sufficient attention. The rate of feed of oil to the tubes is also carefully regulated by means of meters, being checked to plus or minus 5% of the feed per hour.

Hall's plant, with very small alterations, is eminently adapted for the production of aromatic hydrocarbons from petroleum. An installation consisting of eight converters with the necessary complement of dephlegmators, compressors, condensers, and tanks has worked on these lines daily for about eleven months with complete success, a spirit being produced in good yields containing up to benzene 18·5%, toluene 17·5%, xylenes 6·0%. This is easily refined, the refined products containing only traces of paraffin or naphthenes, for instance from 1 to 2% on the finished product. When working for aromatic hydrocarbons, the temperatures and pressures employed are necessarily higher than when working for motor-spirit, being respectively 750° C. and 105 to 110 lb. per sq. in., but these temperatures and pressures are as easily controlled as when working at the lower ones. It might be argued that when working with tubes of this diameter and under these severe conditions of cracking, there is a liability of the tubes becoming choked with carbon. This difficulty was certainly encountered at first, but has been overcome. It is now quite common for a nest of tubes to run over 250 hours without cleaning, and then only a few of the tubes require to be replaced by clean ones and the nest can then be re-started at once. The high speed at which the vapours pass through the tubes causes a scouring action, which carries any carbon formed through to the expansion tubes and dephlegmators, whence it is easily removed. A fairly large amount of gas of high calorific value (1350 B.T.U.) and having a distinct commercial value is necessarily formed when cracking for aromatic hydrocarbons. Incidentally it may be mentioned that the aromatic hydrocarbons contained in the spirit produced can be easily estimated by simple modifications of the James and Coleman tests, determinations by which agree closely with the results obtained by fractionation to pure products. In the higher boiling portions of the spirit, namely those boiling between 150 and 250° C., naphthalene is formed, and has been isolated in a pure state and identified. It is very probable that its derivatives are also present.

The paper by Mr. W. A. Hall describing his process was read before the Institution of Petroleum Technologists in February 1915. It is interesting also to add that Mr. Hall was the inventor of the process for producing elemental sulphur in roasting ores, which was described in our issues of August 1913 and February 1914.

THE DAVIES PULP SAMPLER.

In the November *Bulletin* of the Institution of Mining and Metallurgy, Mr. W. H. Trewartha-James replies at considerable length to the discussion on his paper on the Taylor pulp sampler read at the meeting held in January last. Incidentally he gives particulars of a sampler invented by Mr. A. E. Davies and made by Fraser & Chalmers. We quote the account of the sampler herewith. The feed launder is shown at (*1*) and the discharge launder at (*2*). The sample-cutter (*9*) is mounted on a travelling carriage (*7*) which runs on wheels (*8*). Cords (*6*) are attached to the frame (*7*) and to the quadrants (*5*). The latter are fixed on the axle of the rocking tank (*3*) which is fed by a jet issuing through the pipe (*4*). As the tank tips, the sample-cutter (*9*) is drawn across the stream of pulp. The curvature of the quadrants is arranged so as to minimize the effect of acceleration on the sample-cutter. The distance travelled by the cutter is not more than a few inches, so that acceleration has little effect on the sampling. The rocker is of the usual type and the rate of filling can be regulated so as to vary the interval between sampling. The sample ports are shown at (*10*) and the sample receiver at (*12*). Mr. Trewartha-James recommends trials of this machine.



DETAILS OF THE DAVIES PULP SAMPLER.

USING VOLCANIC WATER FOR POWER PURPOSES.

Geologists are interested in hot springs and geysers in an academic way, and miners collect boron compounds and sulphur, but the application of the waters for the purpose of power production is a novelty. In *Engineering* for November 17, Professor L. Luiggi describes work done in this direction recently in Italy. The geysers and hot springs near Volterra in Tuscany, locally known as "blowers," have been utilized for many years in the production of boric acid and borax, and occasionally for warming the houses in the nearby village of Larderello. The larger proportion of the steam, however, is lost, having no local application, and with it is lost its very valuable heat. Prince Ginori-Conti, the president of the Società Boracifera di Larderello, was the first, in 1903, to try to utilize this steam for the production of motive power. At first he applied a strong jet to a small rotary motor, then to a reciprocating steam engine connected to a dynamo, which generated sufficient current to light part of the borax works. In the meantime he tried to get a more ample supply of steam by boring holes in the ground, lined with iron pipes, driven down to the source of the steam, which is under a hard stratum of rock about 300 to 500 ft. below the surface. These bore-holes vary from 12 to 20 in. in diameter, and give forth steam with a pressure from 2 to 3 and exceptionally up to 5, atmospheres, and at temperatures varying from 150° to 190° C. For several years these jets have not diminished in their capacity, nor does a new boring seem to interfere with the preceding ones, provided the distance from one to another in not less than 50 ft.

Experiments demonstrate that each bore can provide steam at a temperature of at least 150° C., and at the rate from 15,000 to 25,000 kilogrammes per hour, that is, practically, from about 1000 to 2000 horse-power. Thus the possibility of developing motive power is tremendous. Encouraged by these results, Prince Ginori-Conti, in 1906, applied the steam to an ordinary steam engine of about 40hp. The experience of several years has shown that this arrangement works well so far as the mechanical power of the steam is concerned, but that the borax salts and the gases mixed with the steam, especially sulphuretted hydrogen and traces of sulphuric acid, have a corrosive action on the iron parts of the engine and are the cause of frequent repairs.

This difficulty was avoided by applying the steam not directly in the engine, but to a boiler, where its heat is transferred to clean water. A boiler of this sort is known as a Kestner evaporator or calandria. Such a boiler is employed in utilizing heat from molten slag as described in the Magazine for October 1914. The boiler at Volterra is an ordinary multitubular boiler, in which steam is produced at a pressure of 2 atmospheres. The steam is passed through a superheater, and afterwards used for driving a 300hp. condensing steam turbine, directly connected with a three-phase electric generator, which supplies the works and the villages around Larderello. This installation had been at work successfully for several months when the war broke out. Then, coal becoming very scarce, and prices rising to prohibitive limits, the possibility of using this natural steam on a large scale became very important.

Prince Ginori-Conti considered it his duty to carry out a trial on a large scale, availing himself of his long and successful experiments. Acting on the advice of the Tosi Works, of Legnano, specialists in steam turbines and alternating electric generators, he ordered three groups of condensing turbo-electric engines, each of 3000 kw., working with superheated steam at $1\frac{1}{2}$ atmospheres, generated in specially-constructed multitubular boilers. The "blower" steam loses part of its heat in the boiler, reducing its temperature from 180° C. to about 120° C., and is then utilized for the borax industries. The boiler tubes are made of aluminium, which withstands the corrosive action of the natural steam better than other metals. The three-phase current is generated at 4500 volts and is transmitted at 36,000 volts to Florence, Leghorn, Grosseto and other towns, where it is employed largely for power-production at munition works. One of the 3000 kilowatt units has been at work since January 1916, the second since April, and the third has just been started. It is expected that this method of dealing with natural resources will be further extended.

ECONOMIC DEVELOPMENT OF RUSSIA.

At the meeting of the Royal Society of Arts held on November 22, Mr. Leslie Urquhart read a paper entitled "The Economic Development of Russia and Britain's Interest Therein," Mr. Urquhart has had a long and intimate acquaintance with Russian conditions, and he is a trusted friend in Russian business circles. To mining engineers he is known in connection with the Kyshtim, Tanalyk, Russo-Asiatic, and Irtysh companies. We quote that part of his paper dealing with mining.

The mineral wealth of the Russian Empire is recognized today by competent authorities as offering enormous possibilites. The Caucasus, the Urals, Central Asia, and Siberia, all contain vast areas of highly mineralized ground of great promise asking for exploration and development. Some of the deposits of gold, silver, lead, zinc, and copper ores which have been opened up and developed are of world-wide importance and extraordinary value; iron, manganese, magnesite, and all materials necessary for smelting abound; vast salt deposits exist, with coal and sulphur in close proximity for alkali and fertilizer industries; extensive deposits of asbestos and graphite, and basins of the finest coal, petroleum, and oil-shales are well known. The North Urals produce 95% of the world's platinum; there are gold placers and deposits of tin, wolfram, vanadium and other of the rarer metals and precious stones. In short, there is hardly a mineral or metal known in the mining world today that the great Russian Empire cannot produce; and yet these untold riches are lying idle and almost untouched; and, sadder still, instead of being able to supply her own industries and those of the world, there are hardly any of these metals and minerals mentioned, with the exception of petroleum, manganese, salt, and platinum, which Russia, the owner of this vast wealth, has not to import for her requirements.

There is only one reason for this state of affairs: want of means of communication, want of railways and means of transport. Metals and minerals are more often than not found in places remote hundreds and sometimes many hundreds of miles from the one existing trunk railway through Siberia. In a country like the United States, which is well traversed by railways, the miner has only to find, prospect and develop large reserves of ore in his mine, and the railway company will immediately lay a branch to his mine and bring him workmen, machinery, fuel, timber, provisions; the mine owner has only to extract and sell the ore raised from his mine, and the custom smelter will take care of it. The capital necessary for the mine itself is comparatively small, and this makes it possible to work small as well as large mines.

The new railways which are projected and authorized to traverse different parts of Siberia will provide the miner with the means to open up in a short time many mining districts containing large as well as small mineral deposits, and will give a great stimulus to mining and metallurgical enterprise in the country.

Siberia is a country with a good climate, well timbered, with rich virgin lands ready for cultivation, and like all other new countries which are blessed with mineral wealth, its colonization will be all the more rapid if the miner, the pioneer of industry, is given the possibility to open its dormant mineral riches. The settlers will follow the miners as they did in the United States, South Africa, and Australia.

The Russian Empire owes a great deal in the development of its copper, gold, lead, and zinc to British mining capital and enterprise: 50% of the copper and over 30% of the gold in Russia is produced by Anglo-Russian companies. The impulse given to the development of the petroleum industry was largely due to British capital and energy, while it was a British enterprise which introduced modern mining metallurgical methods and processes, which permitted the working of properties that had long remained fallow, or had been abandoned in the Urals and Altai regions. The first and only large metallurgical works producing coke, zinc, and lead in Siberia are the outcome of British enterprise.

Of the more important industrial metals, the production of copper in Russia before the war was only 75% of the consumption, and of its requirements of lead and zinc, 96% and 75% respectively have to be imported. The United States produced in 1913 557,400 tons of copper, and for 1916 it will probably, under present stimulus, produce some 800,000 tons, whereas the Russian production of copper for 1913 was only 33,250 tons. After the war, with an intensive programme of railway construction, the expansion of the iron and steel trade, and the many manufacturing and chemical industries which have been started during the war, the requirements in these metals will increase more and more. Something has already been done in showing the possibilities and exploiting a few of the mineral deposits in the Russian Empire, but the field is so great that what has been done so far is an infinitesimal part of the possible whole.

Take the case of a single metal. In the matter of copper production, Russia is today in about the position of the United States in 1881. The United States produced only 32,000 tons in that year, or just about what Russia did in 1913. The parallelism extends further: the Russian Empire today has, just as that country then had, great copper districts lying undeveloped; how great I cannot pretend to guess. But it does not follow that it will take thirty-five years for Russia to come into her own in the matter of this metal. The way has been found, the methods of mining and treatment have been elaborated, and have become the commonplaces of the modern mining engineer, so that, in the future, years can be expected to show the advance of decades in the past. It is certain that in 1881 a copper ore containing 4% or 5% was scarcely profitable. Today perhaps half the production of the United States comes from ores of less than half that value. Further, long-sighted business men in the United States are today looking forward to the time when even their enormous deposits will show exhaustion, and are casting about for new sources of supply; it is known that their eyes are turning to Russia as the only unexploited civilized country where new sources can be found.

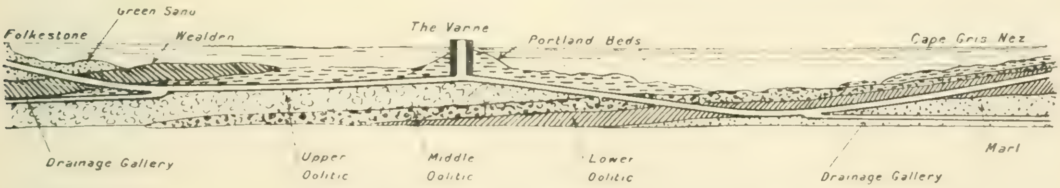
What is true of copper is also true of lead, zinc, and other metals.

A personal experience of twenty years' mining and metallurgical work in the Caucasus, the Urals, and Siberia, in the management and control of Anglo-Russian undertakings employing some 40,000 men, enables Mr. Urquhart to say that in this department of industrial activity British enterprise and capital are welcomed and fostered by the Government. The nation recognizes that British technical knowledge, practical experience, and the capital invested in this direction is an educating and civilizing influence, opens up new country and new industries, gives work and bread to the people, keeps money in the country, and for these reasons the Russian Government has never grudged the earning of large profits by companies or by individuals, recognizing that without this result the capital necessary for the development of the country will not come in.

THE CHANNEL TUNNEL.

In our issues of October and November 1913 we quoted *The Engineer* on the present project for constructing a tunnel from Dover to near Calais, and in July last we referred to the subject, remarking that the geologists had been of great service to the civil engineers in indicating a waterless stratum in the chalk. *The Engineer* has another series of instructive articles in the issues of November 3, 10, 17, and 24, giving a historical account of previous proposals for connecting England and France promulgated during the last hundred years. Many of these projects involved the construction of bridges, jetties, or submerged iron tubes. The chief sian war intervened and the scheme went into abeyance. In 1875 M. Gamond's plan was revived, with the important modification of omitting a mid-way means of access, which in the light of hostilities presented an obvious danger. Just as a concession was granted in France, M. Gamond died.

The English engineers became interested in M. Gamond's proposals owing to models and drawings being shown at the Great Exhibition of 1862. In particular Sir John Hawkshaw commenced a close study of the engineering and geological problems. He found that the Oolite and Wealden beds, through which the



GAMOND'S CHANNEL TUNNEL SCHEME OF 1866.

and most practicable schemes were those for a tunnel, brought forward by Sir John Hawkshaw and Monsieur Thomé de Gamond, although as far back as 1802 the French engineer Mathieu had laid plans for a tunnel before Napoleon. In 1834 M. Gamond proposed a tube on the sea-bed. In 1856 he advocated a tunnel from Cape Gris-Nez to a point mid-way between Dover and Folkestone and passing under the eastern tail of the Varne shoal, through which a ventilating shaft was to be sunk. Later, in 1866, he brought the line of the tunnel farther west so as to pass under the centre of the shoal, and the proposal was to build an island there by dumping the debris brought up from the shaft. The arrangement of the tunnel was such that the shaft should serve not only as a ventilator but also as a means of access. The project received encouragement both in France and England, and in 1869 an international committee was appointed to take the matter in hand. The English engineers on this committee were Messrs. Hawkshaw and Brunlees. The Franco-Prussian war intervened...

Varne tunnel would pass, were not suitable, and he recommended that the tunnel should be farther east so as to pass through the compact grey chalk. This reasoning, as much as the military consideration, caused the abandonment of the Varne project. Afterward Sir John Hawkshaw collaborated with M. Gamond in connection with a tunnel from St. Margaret's Bay, on the east of Dover, to Sangatte, southwest of Calais. The consent of the British Government was obtained in 1875, subsequent to the French Government granting the concession, as already mentioned. The plans were again altered at the Dover end, and boring was commenced between Dover and Folkestone. The reason for this alteration formed the unpleasant incident of the history of the work, and was in effect the jealousy of Sir Edward Watkin, the chairman of the South Eastern Railway. The French engineers started from Sangatte, and at both ends half a mile or so was driven before the British authorities withdrew their permission.

Peat Fuel.—*Engineering* for October 20 gives some details with regard to the value of peat powder as fuel for steam-raising purposes on railways. A large number of experiments were made with locomotives on the Hallsberg-Mjolby section of the Swedish State Railways. The peat powder is carried on the tender in a hopper with a conical bottom. Beneath the bottom is a pipe into which the powder falls, to be carried along by a current of compressed air to a nozzle opening into the fire-box. In the fore part of the fire-box there is a small grate for a coal fire, which serves to ignite the peat powder. The consumption of coal in this grate is 3 to 4% of the weight of the peat burnt. The competitive tests were between all-coal on the one hand, and peat powder with this small proportion of coal on the other. Analyses of the peat and coal were as follows; Peat, 47% C, 29·5% O, 4·5% H, 0·4% S, 1·1% N, 3·2% ash, 14·2% water; Coal 73·5% C, 4·4% O, 8·6% H, 1·5% S, 1·2% N, 6·2% ash, 4·6% water. It was found that the ratio of the weight of peat to the weight of coal required to raise a certain amount of steam is 1·45 to 1.

Producing Zinc Dust.—A paper was read by H. J. Morgan and O. C. Ralston before the New York meeting of the American Electrochemical Society on the production of zinc dust by other methods than in the zinc retorts. This paper is reprinted in *Metallurgical and Chemical Engineering* for October 15. The present demand for zinc dust in America is greater than the supply. Formerly a large amount was imported from Germany and Belgium. At Anaconda, zinc dust is made by atomizing molten zinc by means of a jet of air. The authors have tried the method of producing dust by electrolysing the solution of sulphate, the idea being to make a zinc sponge which easily disintegrates. It is well known that the production of zinc by electrolysis has always been confronted by the bugbear of sponge, and the difficulty of forming a coherent solid zinc except in the purest of electrolytes. The authors therefore are seeking to utilize a metallurgical stumbling-block to commercial purpose. The sponge can be formed if salts of copper or arsenic are present in the electrolyte. Copper is, however, an undesirable constituent of zinc dust as it goes into the precipitate of precious metals when the dust is used in cyaniding. Arsenic is also undesirable in the precipitate, for on treatment of the latter with sulphuric acid, arsine is liberated. In 1907 Sherard Cowper-Coles patented a process for depositing spongy zinc from sodium zincate solution on a revolving iron cathode. Mr. Cowper-Coles employs the zinc thus formed in his process of sherardizing.

Manufacture of Hydrogen. — In our issue of May and October of this year we made brief reference to articles by H. L. Barnitz on methods for producing hydrogen. In our first notice we mentioned that the old process of acting on red hot spongy iron with steam had been revived. Mr. Barnitz describes this new application of an old method in an article published in *Metallurgical and Chemical Engineering* for October 15. This is the invention of Dr. Anton Messerschmitt, and the plant is used extensively by the German war department for filling air-ships. It is also being introduced in America. The plant consists of a furnace built on the regenerative gas furnace plan. Spongy iron is packed between the walls of two concentric iron cylinders. The inner cylinder is filled with open brickwork and the outer cylinder is surrounded with the same, the whole being enclosed in brick walls. After the preliminary heating of the iron sponge, steam is passed through it, and the liberation of hydrogen begins. When the iron is oxidized, the steam is cut off, and producer gas is passed through in order to deoxidize the iron. The producer gas is made from coke and it contains carbonic oxide and hydrogen as reducing agents. The oxidizing and deoxidizing actions take place alternately. It will be seen that the only materials consumed are coke for making producer gas, and steam for making producer gas and for oxidizing the iron. This process is identical with that of Howard Lane which has been in use in England for some years.

Effect of Copper in Iron and Steel.—E. A. and L. T. Richardson read a paper before the New York meeting of the American Electrochemical Society on the effect of small admixtures of copper in iron and steel preventing corrosion. This paper is reprinted in *Metallurgical and Chemical Engineering* for October 15. In 1910 copper-bearing steel was put on the market in America, and the makers claimed that it was the ideal rust-resister. There has since been considerable controversy between them and the champions of pure iron. The present authors undertook tests. They came to the conclusion that, though pure iron and charcoal iron are superior to ordinary steel as rust-resisters, yet an addition of 0·25% of copper to steel makes that steel a better resister than the iron. The addition of copper to iron also increases the capacity to resist rust, but not to the same extent as the steel. The authors are inclined to believe that the protection against rusting is due to some combined action of the copper and the manganese in the steel.

Coal in Borneo and Labuan.—The *Iron & Coal Trades Review* for November 10 prints a paper by William Hopwood, read before the North Wales branch of the National Association of Colliery Managers, giving some account of the coal resources of Northern Borneo and Labuan. This coal is classified as a lignite belonging to the Lower Oolite, and is of excellent quality, being pronounced by the Admiralty to be superior to that of Bengal, Australia, and Japan. Mr. Hopwood gives a history of the attempts to mine the coal on the northwest corner of the island of Labuan. The seams have been worked off and on for sixty years, with indifferent success, owing largely to the water difficulties. The deposits are now in the hands of the Borneo Company, and Mr Hopwood is in charge. He says nothing of his own experiences in this paper, but promises another article containing an account of the present work.

Fibrox.—The Transactions of the American Electro-Chemical Society for 1915 contains a paper by E. Weintraub describing a new inorganic fibrous material called "fibrox." Further details are given by E. F. Northrup in *Metallurgical and Chemical Engineering* for October 1. This material is formed by the slow chemical union of carbonic acid and the vapour of silicon, and its possible composition is represented by the formula SiCO. It is soft and resilient, and has a pale greenish blue colour. As formed in the way described it is an agglomeration of exceedingly fine fibres which can only be seen by means of a lens. Its weight is only about 2½ to 3 grammes per litre, and it is so porous that from 99·5 to 99·9% of its volume is occupied by air. It can be cut into sheets or other self-supporting shapes, and it can be compressed to form stronger sheets. If wetted with water it collapses to slime. Its specific heat is exceedingly small, with the result that a mass can be submitted to intense heat and immediately afterward grasped by the hand. As a heat insulator which will stand a very high temperature it has no equal. On the other hand it does not act as an electrical insulator; in fact it is a free conductor of electricity.

NEW BOOKS AND OTHER PUBLICATIONS

Oilfield Development and Petroleum Mining. By A. Beeby Thompson. Cloth, octavo, 650 pages, illustrated; price 25s. net. London: Crosby Lockwood & Son.

In attempting to cover a subject which has now assumed such colossal dimensions in a volume of some 600 pages, Mr. Beeby Thompson has undertaken a task of no mean magnitude. Although those parts of the volume dealing with the practice of the oilfield development might have been expanded at the expense of those parts dealing with speculation upon academic problems, the author has added to the literature of the subject a volume which will be of service to all branches of the profession.

That such a text-book was needed has been clearly demonstrated for some time past owing to petroleum technology being included in the curriculum of modern Universities. The student will find in this book a fund of information from which he cannot fail to benefit. Furthermore, the book will have a large army of readers in the rank and file of petroleum engineering, for it is written in a clear and easy style, which will commend itself to all who desire to increase their knowledge of the subject. While for those whose experience may be wide, a book of reference of this character will be equally welcome.

The work consists of 14 chapters, with a sub-division of matter carefully proportioned so that each section, important in itself, forms a connecting link with the subject matter as a whole. A careful review is given of the geographical distribution of petroleum throughout the world, and a short account is included of the more important sources of supply, with useful maps of reference. It is a pity the author did not indicate the source from which more detailed data could be obtained on each oilfield referred to, for it would have added greatly to the value of an otherwise excellent résumé of this side of the subject.

Another chapter is devoted to the tenure of petroleum lands, and much useful information is recorded.

To the geology of the question and the much debated theories on the origin of petroleum, four chapters claim a large portion of the volume; and here perhaps too much space has been devoted to a branch of the subject which could have well formed the material of a separate volume, thus allowing more space to the more practical problems so well discussed in the remainder of the work.

A chapter is devoted to the systems of drilling, and another to the lining and repairing of wells, and an excellent account is given of the all-important problem of the exclusion of water from oil sands. The extraction of oil from the bore-hole forms a well balanced chapter, and in this section the author is seen at his best, for he describes with graphic clearness the procedure necessary for securing and maintaining the production of a proved field.

In dealing with the selection and transmission of power a careful review of present oilfield practice is detailed, and the reader is led to contemplate upon further developments that may occur in the future handling of power in established fields. Due attention is rightly directed to the necessity for careful records in all phases of oilfield technology, and many excellent examples are quoted. The chapter on oilfield organization, which the author appreciatively attributes to Mr. Percy R. Clark, adds greatly to the value of the work.

The concluding pages are devoted to a set of useful data which cannot fail to be of value to students and workers in the great field of engineering. Half a page is devoted to the subject of divining for petroleum, which might well have been excluded from a volume dealing with the scientific side of oilfield development. Indeed the author's allusion throws no light upon an ancient fraud, too frequently used by unprincipled imposters.

As already indicated the work fills a gap in the literature of Petroleum Technology and will surely find a wide circulation, written as it is in an attractive style, well illustrated, and published within convenient dimensions. In conclusion it is suitable to add that this work is the successor of one entitled "Petroleum Mining" issued some years ago, which was a helpful and reliable handbook.

JOHN CADMAN.

Étude Comparée des Gites Platinifères de la Sierra de Ronda et de l'Oural. By Louis Du Parc and Augustin Grosset. Published at Geneva.

This brochure, being No. 5 of Volume 38 of the Memoires de la Société de Physique et d'Histoire Naturelle de Genève, reviews in comparative light two deposits of platinum in widely separated areas.

The Sierra de Ronda, on the south coast of Spain, lying about 15 miles from the coast, and 50 miles to the northeast of Gibraltar, contiguous to the Mediterranean coast, is composed essentially of a core of peridotite, composed of pyroxene and basic plagioclase, this core being flanked and intersected by areas of gneiss, limestone, and Cambrian schists. The dike or core of peridotite extends in a northeast direction about 20 miles, and in its mass several peaks of from 3000 to 4000 ft., of Alpine sharpness of outline, have been developed. The complex is intersected by about fifteen water-courses, all having a direction from north to south, varying from 12 to 3 miles in length. These, of which the principal are the Guadalmina, Guadaissa, and Verde, all have torrential form at their source, and then pass through a swift canon stage to the flat wandering base levelled stage near their mouths.

Platiniferous gravels are found in all the streams at points tested in the canon and flood-plain areas, the grains of platinum being finer than Ural platinum grains, and invariably coated with a black rust, supposedly due to chromic iron with which the grains are associated in the rock.

Crystalline impressions, corresponding to the form of pyroxene crystals, are seen microscopically indenting some of the grains, indicating the source of the platinum as indigenous and as an original constituent of the peridotite. Grains weighing ½ gramme are rare and the largest "nugget" obtained so far weighed 2 grammes.

The gravels, practically absent in the upper portions of the rivers, assume a thickness of 40 to 50 ft. in the flood plain areas near the sea, and are of small and uniform size, the pebbles being of peridotite, gneiss, and schist. There is no clay, and the platinum is distributed uniformly throughout the section of gravel with the exception of the upper 10 ft. Whether they contain an economic yield for dredging has evidently not been determined up to the present.

Professor Du Parc compares this platiniferous area with that of the Tagil district in the Ural region of Russia, which he had previously visited. There, the original habitat of the platinum is a dunite core, a rock consisting of olivene and chromite. The platinum has been frequently observed associated with the latter, although hitherto no profitable attempt to work the dunite as an ore of platinum has been made.

The dunite batholiths of the Ural, witb which the platinum deposits are generally associated, are far more extensive and regular in occurrence than those in any other locality hitherto known, and are in no sense comparable geologically with the Spanish occurrence. In the Ural the dunite is invariably surrounded with an aureole of pyroxenite, and generally this in turn with an outer ring of gabbro. Platinum in that district has been rarely observed as coming from peridotite areas.

The gravels in Spain are also different in character, being the product of recent and comparatively short erosion, while the Ural platiniferous gravels are in wide flat valleys, with shallow alluvium, the overburden of 7 or 8 ft. carrying little value, while the pay gravel, mixed with much clay, and from 4 to 5 ft. thick, is extremely productive in platinum, which also makes its way a few inches into the soft bedrock. The erosion of the Ural region has been so long continued that little but the stumps of the former hills remain.

The authors' pamphlet is illustrated by photographs of the Spanish locality and with photo-micrographs of thin sections of the Ronda rocks. Microscopic descriptions and chemical analyses of typical peridotites of the region are given.

Should the Ronda locality prove a commercial source of platinum, the paper might acquire considerable interest, but at present it is difficult to see any great value which attaches to the comparison between the two districts.

C.W.P.

TECHNICAL PAPERS FOR THE MONTH

British.

Colliery Guardian.—*November 3:* The Rheolaveur, a New Coal Washer, invented in Belgium; Hydraulic Packing at Ballapur Colliery, India, R. S. Davies. *November 17:* Power Equipment of the Valleyfield Colliery, Scotland. *November 10:* Coaling at Balboa, Panama Canal, F. J. Warden-Stevens; Coal-Dust Experiments at Derne, Germany, from *Glückauf*. *November 24:* American Coal Tipples, H. J. Edsall

The Engineer.—*November 3:* Historical Account of Various Channel Tunnel and Other Projects [continued November 10, 17, 24]; Review of H. C. Hoover's and T. A. Rickard's Books on Flotation. *November* 17: American Caterpillar Petrol Engines for Traction and Trench Digging supplied to the Russian Army. *November 24:* The Manufacture of Tungsten at the works of the High-Speed Alloys Co. Ltd. Sinking Shafts by the Freezing Process at Llay Hall Colliery, Wrexham.

Engineering.—*November 3:* Nitrogen Oxides made from Ammonia by the Ostwald Process applied to the Manufacture of Sulphuric Acid by the Chamber Process, from *Metall und Erz* January 22, 1916; High-pressure Air Compressors, J. M. Ford [continued November 10 and 17]. *November 10:* Discussion on Refractory Materials at the Faraday Society [continued November 17]; Electricity generated from Volcanic Springs, Professor Luiggi. *November 24:* The Donald Portable Elevator-Conveyor, intended primarily for ships, G. F. Zimmer.

Faraday Society.—*November 8:* Refractory Materials, various papers by Sir R. A. Hadfield, J. W. Mellor, F. J. Bywater, E. Griffiths, A. Cliff, Cosmo Johns, E. P. Page, P. G. H. Boswell.

Institution of Petroleum Technologists.—*November 21:* Pyrogenesis of Hydrocarbons, or cracking of oils by heat, E. L. Lomax, A, E. Dunstan, F. B. Thole.

Iron & Coal Trades Review.—*November 3:* Jigging Conveyor for Use Underground, W. A. Machin (paper read before the North Staffordshire Branch of the National Association of Colliery Managers); Hydraulic Method of Filling at Ballapur Colliery, India, R. S. Davies. *November 10:* Discussion on Refractories at the Faraday Society [continued November 17]; Coal-Mining in Borneo, W. Hopwood, a paper read before the North Wales Branch af the National Association of Colliery Managers. *November 17:* Swedish Iron, Steel, and Coal Industry in 1915. *November 24:* Face Conveyor at Birch Coppice Colliery, on the Meco System; Ancient and Modern Constructon of Miners' Safety Lamps, W. Best, a paper read before the Scottish Branch of the National Association of Colliery Managers; Coke-fired Regenerative Muffle Furnaces for Metallurgical Work made by the Richmond Co., Warrington.

Midland Institute of Mining, Civil, and Mechanical Engineers.—Making a Shaft Upwards, G. Blake Walker.

Royal Society of Arts.—*November 22:* The Economic Development of Russia and Britain's Share Therein, Leslie Urquhart. *November 27, December 4 and 11:* Coal and its Economic Utilization, J. S. S. Brame.

Colonial.

Australasian Institute of Mining Engineers Proceedings.—*September 30:* Cyclometer Surveys, Leslie H. Ower.

Canadian Mining Institute Bulletin.—*November:* Report by Institute Committee on the Canadian Metal Trades and Preparedness; Zinc Production in British Columbia, J. P. Keane; Notes on the Metallurgy of Copper, David H. Browne; Sodium Sulphide Precipitation of Silver at the Nipissing Mine, R. B. Watson.

Canadian Mining Journal.—*October 15:* The Labour Dispute at Cobalt; Zinc Deposits of Montauban Township, Quebec, J. A. Bancroft. *November 1:* Methods and Costs of Placer Mining in the Yukon; Mining Possibilities along the Canadian Northern Railway from West Shining Tree to Nipigon, Cyril T. Young.

Chemical, Metallurgical, & Mining Society of South Africa Journal.—*September:* Recent Advances in Chemical Industry, J. A. Wilkinson, presidential address.

Mining and Engineering Review, Melbourne.—*September:* Quarrying and Shipping Iron Ore from Iron Knob, South Australia; Mount Royal Copper Mine, Tottenham, New South Wales. *October:* The Milling of Gold Ores, practical hints for operators, J. McCombie; Precipitation of Gold and Silver on Zinc Dust, F. Danvers Power; Dredging for Minerals retrospective and prospective, F. W. Payne.

Queensland Government Mining Journal.—*September:* Deposits of Chromite in Queensland, B. Dunstan; Prospects of the Deep Ground at Black Ridge, Clermont, L. C. Ball. *October:* Queensland's Resources in Aluminium, Alumina, and Alum, B. Dunstan; The Mount Mudlo Copper Mine, Kilkivan, E.

C. Saint-Smith ; Mount Wonga Gold Mine, Gympie, B. Dunstan.

West Australian Chamber of Mines Journal.—*August:* The Position with regard to Alien Subjects on Mines.

FOREIGN.

American Institute of Mining Engineers Bulletin. —*November:* Conservation of Phosphate Rock in the United States, W. C. Phalen ; Geology and Ore Deposits of Mojave County, Arizona, F. C. Schrader ; Influence of Movement in Shales on the Area of Oil Production, R. A. Conkling ; Function of Alumina in Slags, C. Henrich ; Matte Granulation at Herculaneum, Missouri, S. P. Lindau and H. B. Smith ; A Study of the Silica Refractories, J. S. McDowell ; Genesis of Asbestos and Asbestiform Minerals, S. Taber.

Economic Geology. — *October-November:* Relation of Ore Deposition to Faulting, J. E. Spurr ; New Zinc District in New York, D. H. Newland ; Experiments relating to Secondary Enrichment of Mercury Deposits, T. M. Broderick ; Wood Tin in Tertiary Rhyolites, Northern Nevada, A. Knopf ; Pitchblende Deposits of Gilpin County, Colorado, E. S. Bastin ; Titaniferous Magnetite Ores in Ontario, W. G. Foye ; Aluminium Hydrates in Arkansas Bauxite Deposits, discussion of D. C. Wysor's paper, by L. L. Fermor.

Engineering and Mining Journal. — *October 21:* Origin of the Southwest Virginia Lead-Zinc Deposits, S. H. Ball and L. S. Thompson. *October 28:* Graphite Industry in New York, R. W. Jones ; Copper Smelting at Naltagua, Chile, Mark R. Lamb ; Potash in the Salduro Salt Deposit, Utah, H. S. Gale ; Gold-mining in Idaho, R. N. Bell. *November 4:* Shaft-sinking at the Orkla pyrite mine in Norway by an American Company, L. D. Cooper ; The Jobke Magnetic Separator ; Flotation Tests on an Antimony-Gold Ore, E. R. Pilgrim ; Extraction of Beryllium from Gadolinite. *November 11:* A Trip through Honduras, D. McBride.

Metallurgical and Chemical Engineering.—*October 15:* The Effect of Copper in Iron and Steel to Prevent Corrosion, E. A. and L. T. Richardson ; Manufacture of Hydrogen by the Messerschmitt Process, H. L. Barnitz ; Methods of Making Zinc Dust, H. J. Morgan and O. C. Ralston. *November 1:* Development of the American Potash Industry, F. M. De Beers ; An Explanation of the Flotation Process, A. F. Taggart and F. E. Beach ; Cracking of Paraffin-Base Oils, Egloff, Twomey, and Moore ; Properties of Foundry Irons, J. E. Johnson.

Mining and Engineering World. — *October 14:* Stevens Process for Separating Metals from Flue and Bag-house Dust ; Sutton and Steele Sizer and Classifier. *October 21:* Concentrating Tungsten Ores in Boulder County, Colorado. *October 28:* Continuous Counter-Current Agitation and Decantation, C. F. Spaulding. *November 11:* Flotation at Kennecott Copper Mine, Alaska, H. J. Stander.

Mining and Scientific Press.—*October 21:* Concentration of Low-grade Copper Ores by Flotation at Stoddard, Arizona, C. B. Clyne ; Mexican Mining Law, Abstracts of Recent Decrees. *October 28:* Electrolytic Methods of Precipitating Precious Metals from Cyanide Solutions, E. C. Morse ; Graphic Method for Correcting Steel Tapes, W. S. Weeks ; Discussion on Flotation at the Arizona meeting of the American Institute. *November 4:* A "Journey of Observation" in British Columbia, T. A. Rickard ; Potash-bearing Minerals of California, Herbert Lang ; Measuring with the Steel Tape in Mine Surveying, W. S. Weeks.

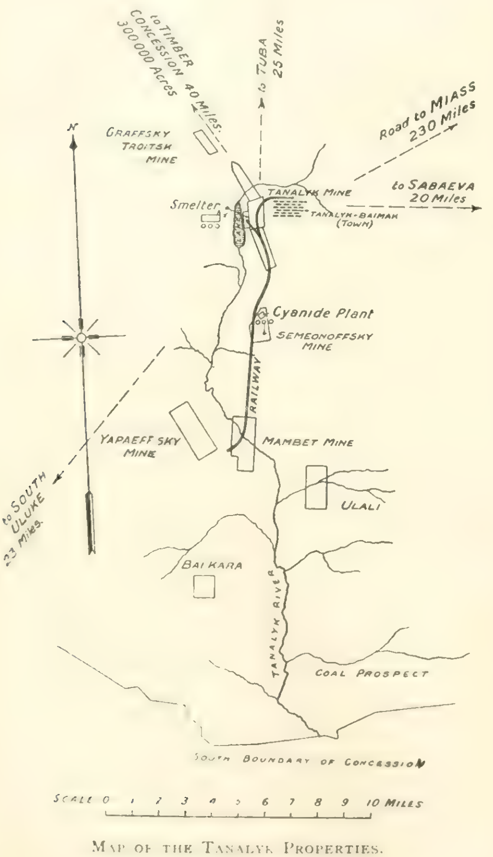
YEARLY REPORTS OF MINING COMPANIES

Broken Hill South.—The report for the half-year ended June 30 shows that the output of ore was greatly restricted by the strike. From January 10 to February 14 the mine was idle, and subsequently only four or five days were worked per week. Altogether, out of 26 weeks, 9½ were lost. The ore raised totalled 92,553 tons averaging 14·5% lead, 13·4% zinc, and 6·8 oz. silver per ton. At the lead mill, 16,985 tons of lead concentrate was extracted, averaging 59·8% lead, 9·6% zinc, and 21·2 oz. silver. In additon 51,157 tons of zinc tailing was produced averaging 16·3% zinc, 3·1% lead, and 3 oz. silver ; together with 13,770 tons of slime averaging 14·5% lead, 13·4% zinc, and 6·8 oz. silver. The zinc tailing was delivered to the Amalgamated Zinc (De Bavay's) Co. for treatment. Some of the slime (846 tons) was sent to the Port Pirie smelters. The selective flotation process for treating slime has been started, and lead concentrate is being produced ; the zinc section is not yet complete. The accounts show credits of £346,353. The working cost at the mine was £120,390, allowance for income tax £21,060, interest on debentures £6000, allowance for depreciation £7794, and administration expenses £4602. The shareholders received £120,000, being at the rate of 60% for the half-year. As regards development it will be remembered that last year the 1270 ft. level was not giving as good results as the levels above. Since then the prospects have substantially improved, for four out of five bore-holes have disclosed thicknesses of average ore varying from 20 to 143 ft.

Jantar Nigeria.—This company was formed in 1912 to acquire alluvial tin ground near Jos, at Naraguta, Northern Nigeria. P. C. Tarbutt, E. W. Janson, and Oliver Wethered are the directors, and H. D. Allen is manager. The report for the year ended September 30 last shows that 261 tons of tin concentrate was won, as compared with 162 tons the year before. The accounts show credits of £27,657, and a net profit of £10,261, out of which £7500 was distributed as dividend, being at the rate of 12½%. The working cost during the past year was £78. 16s. 3d. per ton, as compared with £87. 7s. 4d. during the previous year. The average price realized for the concentrate was £118. 1s. per ton, as compared with £105. 14s. the year before. During the year new mining leases were granted to the company, covering an area of 441 acres, bringing the total area now held under mining leases to 1697 acres.

Malayan Tin Dredging.—This company was formed in 1911 to acquire alluvial tin lands near Batu Gajah, in the Kinta district of Perak, Federated Malay States. The company is housed in the same office as the Tronoh, Lahat, and Sungei Besi companies. Nutter & Pearse reported on the properties, F. W. Payne & Co. designed the dredges, and A. C. Perkins is manager. The ground treated is suitable for bucket-dredging, the conditions being outlined by Harry D. Griffiths in his article published in this issue. The first dredge commenced wotk at the beginning of 1913, the second in April 1914, the third in September 1914, and the fourth in October 1915. The report for the year ended June 30 last shows that the four dredges treated 3,252,000 cubic yards for a yield of 1020¾ tons of tin concentrate, averaging 74·8% metallic tin, and selling for £105,895. This was equivalent to an extraction of 0·7 lb. or 11d. per yard. The working cost was £44,882, the administration expenses £3681, and the allowance for depreciation £15,246, leaving a net profit of £43,020. Out of the profit dividends absorbing £24,200 have been paid, aggregating 20%. The remaining balance has been carried forward to provide for excess profits tax. The area dredged during the year was 44¾ acres, making the total treated to date 94 acres. The land held by the company measures 1210 acres.

Tanalyk Corporation.—This company was formed in 1912 for the purpose of purchasing the shares of the South Urals Mining & Smelting Co., a Russian company owning copper and gold deposits in the southern Urals. The company is in the same control as the Kyshtim Corporation. The chief copper mines are the Tanalyk, Mambet, and Ulali, and the gold mines are the Semeonovsky and Tuba. Smelting in a reverberatory commenced in April 1914, and cyaniding was



MAP OF THE TANALYK PROPERTIES.

started at Semeonovsky in August 1915. A blast-furnace was erected during the latter part of 1915. The report now issued covers the year 1916, but with it there is issued a report by R. Gilman Brown, the consulting engineer, bringing the information up to June 1. The accounts of the South Urals company show a profit of 685,057 roubles, out of which 422,396 roubles has been written off for depreciation, and 47,953 roubles placed to reserve. The remainder, 214,707 roubles, which is subject to Russian taxation, is carried forward. The English company has an issued capital of £353,991, and there are £198,357 debentures. During 1915, the smelting plant treated 33,445 tons of ore for a yield of 605 tons of blister copper averaging 98·14% copper, 19·38 oz. gold, and 170 oz. silver per ton. During the first six months of 1916 the yield was 298 tons of blister averaging 98·39% copper, 28·89 oz. gold, and 204·8 oz. silver. The cyanide plant produced 1906 oz. gold and 752 oz. silver, from the start in August to the end of 1915. The plant is being altered in order to improve the extraction, without interfering with its operation. The important feature in connection with development during the year has been the opening of the Tuba mine. Large amounts of oxidized ore rich in gold have been proved, and the sulphide ore has been reached by drill-hole. The reserves of definite sulphide ore are as follows: Mambet 55,000 tons averaging 2·35% copper, 6·57 dwt. gold, and 6·7 oz. silver; Ulali 28,300 tons averaging 2·3% copper, 6·5 dwt. gold, and 6·6 silver; Tanalyk 7500 tons averaging 3·54% copper, 3·44 dwt. gold, aud 2 oz. silver; and 5400 tons at the Troitzk and Yapaensky. Of oxidized ore reserves there are 82,000 tons at Semeonovsky averaging 12·2% dwt. gold, and at Tuba 23,000 tons aveaging 1% copper, 68 dwt. gold, and 20 oz. silver. The sulphide ore at Tuba is estimated to average 13% copper and 1·4 dwt. gold.

Kyshtim Corporation.—This company was formed in 1908 to purchase the entire share capital of the Kyshtim Mining Works, a Russian organization owning estates in the Ural mountains containing copper and iron mines and smelters. On several occasions we have published much information relating to the reorganization of copper-smelting methods and the geological investigations undertaken by Anglo-American engineers and capitalists. The report now issued covers the year 1915. The ore mined was as follows: From the Konuikhoff mine 110,920 tons, Smirnoff 145,105 tons, Tissoff 73,454 tons, Americansky 31,026 tons, Ivanoffsky 1245 tons, total 361,750 tons. The metal content of the ore did not vary greatly at the different mines and averaged 3·05% copper, 1·8 dwt. gold, and 1·1 oz. silver. The coarse ore was smelted at the company's blast-furnaces at Karabash, and the fine was treated in the reverberatory furnace at Kyshtim, the matte there produced being sent to the Karabash smelter. At the refinery 7642 tons of copper was produced, but the amount of precious metals saved is not mentioned. By development and diamond-drilling the reserve has been increased by 745,000 tons. The reserves estimated on the basis of development and bore-holes at the various mines are; Konuikhoff 616,000 tons, Smirnoff 949,000 tons, Americansky 567,000 tons, Tissoff 388,000 tons, and Ivanoff 15,000 tons, total 2,535,000 tons. The ore ready for stoping on May 1 last was 353,800 tons averaging 2·9% copper. Details of financial results for the year were given in our lost issue.

Messina (Transvaal) Development.—This company was formed in 1905 by A. M. Grenfell to acquire a copper property in the northern Transvaal. On Mr. Grenfell's bankruptcy two years ago, the control changed hands and H. C. Hoover joined the board. The mine was re-sampled by A. F. Kuehn, and details of his results were given in our issue of December 1915. The report for the year ended June 30 shows that 111,909 long dry tons of ore averaging 5·4% copper was raised, out of which 894 tons averaging 45·3% copper was removed by hand-picking. The remainder, together with 6888 tons of old sand and slime averaging

5%, was sent to the concentrator, where 11,056 tons of shipping concentrate averaging 42·9% and 5251 tons of smelting concentrate averaging 18·1% were produced. At the furnace, 1737 tons of matte was produced averaging 56·9% copper. The hand-picked ore, the high-grade concentrate, and the matte were sold for £559,202. The profit was £268,721, out of which £15,000 was paid as debenture interest, £42,600 was paid as taxes, and £140,000 was put on one side for excess profits tax. The shareholders received £36,357, or 5%, this being the first dividend ever paid. The large appropriation for excess profits tax is explained by the fact that the earning of profits has only just begun. The ore raised during the year averaged 5·4% copper as already mentioned; the year before, the average content was 7·3%. The reserve of practically proved ore is estimated at 151,409 tons averaging 5·23%, as compared with 131,700 tons averaging 6·63% the year before. The possible ore is estimated at 56,652 tons averaging 3·43%, as compared with 43,700 tons averaging 3·74%. Geological examinations recently made are encouraging for further development in depth and also laterally. H. C. Hoover has resigned from the board and J. A. Agnew has been elected in his place.

Zaaiplaats Tin.—This company was formed in the Transvaal with offices at Pretoria in 1908 to acquire tin deposits in the Waterberg district north of Pretoria. During the early years large profits were made from ore averaging over 5% metallic tin. More recently the ore developed has been lower in grade, the veins are difficult to follow, and there is no reserve ahead of the requirements of the mill. The report for the year ended July 31 shows that 36,425 tons of ore was raised, and after the rejection of 31% waste, 28,829 tons averaging 1·5% metallic tin was sent to the stamp mill. From this, 477 tons of concentrate was produced. In addition per 16,224 tons of old middling averaging 0·5% metallic tin per ton was treated for a yield of 41 tons of concentrate. There was also produced 13 tons of concentrate from alluvial deposits. The sale of concentrate brought an income of £55,882. The net profit was £3290, which was carried forward. Four years ago the production of concentrate was 1647 tons, and £90,000 was distributed as dividend, being 150% on a capital of £60,000. The prospects at the mine are gloomy. In No. 13 section the main orebody is exhausted and exploration of branch veins has been undertaken. In No. 6 section the orebody is now unprofitable. On July 31, 5902 tons on the dump remained for treatment, as also 14,230 tons of old middling. As reported in our issue of May last, adjoining claims have been purchased from the Transvaal Consolidated Land Co. Development work is now being done, but it is too early to record any results.

Simmer & Jack Proprietary Mines.—This company was formed in 1887 to acquire property in the middle east Rand. The mine has been producing regularly since 1888, and at one time was a leading producer on the Rand, though the grade of the ore has always been lower than at the best mines in the Central Rand. The control is with the Consolidated Gold Fields of South Africa. C. D. Leslie is superintending engineer, and O. P. Powell is manager. The report for the year ended June 30 last shows that the grade of the ore treated fell materially during the latter half of the period, and that the profitableness of some of the ore remaining in the upper levels became open to doubt. For this reason attention had to be transferred to the deeper portions of the mine, involving expenditure on improvements in winding and also causing an increased cost. The ore raised was 369,063 tons from reclamation and 435,760 tons from stoping and development, making a total of 804,823 tons. Of this, 797,900 tons was sent to the mill. The yield of gold was 210,969 oz. worth £880,278, being 5·29 dwt. or 22s. per ton milled. The working cost was £576,486 or 14s. 5d. per ton, £11,480 was spent on renewals, and £32,274 was paid as profits tax and war levy. The dividends absorbed £262,500, being at the rate of 8¾%. The working profit was £111,370 less than the year before, and the working cost per ton 1s. 6d. higher. The reserve is estimated at 1,935,000 tons averaging 5·2 dwt. per ton, a decrease of 200,000 tons during the year. This does not include reclamation ore, of which no estimate can be made. There are few blocks awaiting development at the bottom of the mine.

Sub-Nigel.—This company was formed in 1895 to acquire property on the dip of the Nigel mine, in the Heidelberg district, on the southern side of the Far East Rand basin. In 1909 the adjoining property of the Nigel Deep was absorbed. The control is with the Consolidated Gold Fields of South Africa. The company did not enjoy as much prosperity in early days as the Nigel, but now when the Nigel is in difficulties, the Sub-Nigel is greatly improving in condition. The report for the year ended June 30 last shows that 142,164 tons was mined, and after the rejection of waste, 91,130 tons was sent to the stamps. The yield by amalgamation was 26,258 oz. and by cyanide 17,157 oz., being a total of 43,415 oz., worth £180,926. The yield per ton milled was 9½ dwt. or 39s. 8d. The working cost was £148,167, leaving a working profit of £32,759, or 7s. 2d. per ton. The shareholders received £32,368, or 7½%. As compared with the previous year, the tonnage milled was 32,660 higher, the cost per ton was 3s. less, the working profit £24,364 higher, and the dividend compared with 2½%. During the year, development has added 24,000 tons to the reserve, which now stands at 214,000 tons averaging 9·1 dwt. per ton, with 24,000 tons of partly developed ore averaging 9.6 dwt. Present development indicates a further increase in reserve and in its content, and an increase in the treatment plant to 11,000 tons may be considered shortly.

Middleburg Steam Coal & Coke.—This company was formed in 1902 under Cape laws to acquire coal lands in the Witbank district of the Transvaal. It was reconstructed in 1906 under English law. Alan Cadell is chairman of the company, A. T. Macer managing director, and E. M. Goodwin general manager at the mine. The report for the year ended June 30 shows that the output of coal was 297,224 tons, an increase of 25,490 tons on the previous year. The trading profit, after allowance for depreciation, was £17,333, out of which was paid £830 as debenture interest, £1543 as London expenses, £3611 as taxes, and £3244 as preference dividend, while £2500 was placed to reserve. The ordinary shareholders received £7491, being at the rate of 7½%. The new electrical equipment has caused a decrease in labour costs. The power-plant is sufficient to handle 35,000 tons per month instead of 25,000 as at present, and the manager is only waiting for an improved demand to increase the output.

Witbank Colliery.—This company was formed in 1896 to acquire coal deposits in the Middelburg district of the Transvaal, about 90 miles east of Johannesburg. The sale of coal commenced in 1898, and increased gradually until 1909, since which date the yearly output has been fairly regular. The control is with Neumann's, P. M. Newhall is acting consulting engineer, and J. K. Addie is manager. The report for the year ended August 31 shows that the deliveries from the Witbank mine were 527,196 tons, and from the

Uitspan mine 323,652 tons, making a total of 850,848 tons, an increase of 59,525 tons as compared with the previous year. The trading profit for the year was £67,173, and £52,500 was distributed as dividend, being at the rate of 25 per cent.

Glynn's Lydenburg.—This company was formed in 1895 to acquire a gold mine on the Sabie river, near Pilgrim's Rest, in the Lydenburg district of the Transvaal. The control is with the Central Mining group, and G. C. Damant is manager. Milling started in 1897, and dividends averaging 20% have been paid continuously. The report for the year ended July 31 shows that 37,289 tons was mined from the Mill Hill section and 11,815 tons from the Werf Mynpacht. The yield of gold by amalgamation and cyanide was worth £90,632, or 36s. 11d. per ton milled. The working cost was £54,101 or 22s. 2d. The shareholders received £27,625, or 16¼%. The ore reserve stands at 78,282 tons averaging 8·7 dwt., of which one third is in the Mill Hill section and two-thirds at the Werf Mynpacht. These figures show an increase of 13,282 tons and 0·3 dwt. as compared with those of a year ago. At Compound Hill development work has resulted in the opening of additional reserves, which are not yet blocked out.

Gaika Gold.—This company was formed in 1902 to acquire a gold-mining property near the Globe & Phœnix, Rhodesia. Willoughby's Consolidated and the Rhodesia Exploration & Development were concerned in the flotation, but the Gold Fields Rhodesian Development Co. has been in control since 1912. Milling commenced in 1905, and dividends were first paid in 1911. The report for the year ended June 30. last shows that no further ore has been found in depth, and that sinking below the 14th level has been suspended. The exploratory work based on the geological investigations of Professor D. P. McDonald have yielded no result so far. Mr. McDonald is expected to pay another visit shortly. During the year, 37,795 tons of ore was raised and treated, for a yield of gold worth £90,330. The working cost was £51,444, allowance for depreciation £4617, and London expenses £1902. The shareholders received £34,187 or 12½%. Though no ore has been discovered in depth, the upper levels continue to disclose further supplies, so that the reserve has been fairly well maintained. The figures at June 30. were 89,591 tons averaging 13·96 dwt. per ton, as compared with 95,570 tons averaging 14·14 dwt. the year before.

Taquah Mining & Exploration.—This company was originally formed in 1888, as the Taquah & Abosso Gold Mining Co. to acquire gold-mining properties in West Africa. From 1892 to 1898 milling was conducted on a small scale. In 1901 the company was split, and the Abosso property was transferred to a subsidiary. The first dividend paid by the Taquah company was distributed in 1909, and the second in 1914. Present conditions at the mine indicate the continuance of dividends for some years. Control passed to the Oceana Consolidated six years ago and additional capital for development was then provided. The report now issued covers the year ended June 30 last. During this period, 68,012 tons of ore averaging 61s. 6d. per ton was treated by amalgamation and cyanide, for a yield of gold worth £202,005. This was equivalent to an extraction of gold of 59s. 5d. per ton, and a percentage of recovery of 96·5. During the last few months the extraction has been further improved and only about 1s. 6d. is now left in the tailing. The working cost was £116,707 or 34s. 3d. per ton. In addition, £16,180 was written off for depreciation, £3400 was written off expenditure on shaft-sinking, and £1293 was spent on diam nd-drilling and on native huts. The sum of £5821 was received as dividends on the company's holding in the Abosso. The shareholders received four quarterly dividends of one shilling each, absorbing £77,495, or 20%. The ore reserve is estimated at 209,299 tons averaging 56s. 9d. The new ore-shoot discovered a year ago in No. 10 level south has been developed in this level and in the 11th level, and by a winze below the latter level. The 12th level is being driven to meet this winze. Several upper levels are being extended so as to find this ore-shoot. At first, the ore disclosed in this shoot was lower than that in the main orebody, averaging only 42s. per ton, but in the winze the assay-value is 58s. over 5 ft. It will be remembered that the main orebody was found to be disturbed and of low-grade below the 13th level. Further exploration by sinking and by drill-hole recently undertaken gives promise of an improvement in conditions at greater depth.

Abosso Gold.—As mentioned in the previous paragraph, this company was formed in 1901 as an offshoot of the Taquah Mining & Exploration Co. The ore is of lower grade than in the Taquah mine. Dividends have been paid since 1906, except in 1912. The report now issued covers the year ended June 30 last. During this period 113,300 tons of ore was sent to the stamps, and the yield of gold by amalgamation and cyanide was worth £179,458, or 31s. 8d. per ton. The gold remaining in the residues averaged 4s. 6d. per ton. In addition, 6740 tons of accumulated slime was treated, for a yield of £2764. The mill also treated 13,614 tons of custom ore. The working cost, including development redemption, was £141,600 or 27s. per ton milled. The amount written off was £15,203, and administration expenses totalled £3552. The net profit was £25,023, out of which £20,000 was distributed among shareholders, being at the rate of 5%. The ore reserve was calculated on June 30 at 237,280 tons averaging 32s. 6d. per ton, as compared with 270,700 tons averaging 33s. 3d. per ton the year before. To off-set the fall in the average content, the working costs were reduced by 2s. per ton during the year. Steps are also being taken to improve the extraction, and with this object a tube-mill is being installed in order to grind the sand finer. At the mine, exploration of the West lode has been commenced from the main shaft. Cross-cuts from the 11th and 12th levels have been driven to the lode, and driving, rising, and sinking have been done. The average assay-value of the ore so far disclosed is 36s. 3d. per ton over a width of 63 inches.

Tolima Mining. — This company was formed in 1871 to acquire the Frias silver mine in the State of Tolima, Colombia. In the early days the operations were highly profitable, but in 1903 and 1909 reconstructions became necessary in order to provide funds for further developments. Since then small dividends have been paid and the debentures redeemed. Unfortunately in October 1915 it became impossible for English lead-smelters to smelt the concentrate, and the company had to stop production for a while. The report for the year ended June 30 last shows that the smelters resumed treatment in February of this year, and that by the end of 1916 the whole of the accumulated material will have been smelted. As the benefit of the present high price of silver will be obtained, the finances of the company will be greatly assisted. During the year under review, 6310 tons of ore was raised, and 497 tons of concentrate was produced assaying 453 oz. silver and 15¾% lead. The output was about half of normal. The reserve is estimated to yield 1757 tons of concentrate. A. J. Russell is managing director, and John Russell is manager.